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ETHOLOGY, THE COMPARATIVE STUDY OF ANIMAL BEHAVIOR

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ETHOLOGY is an approach to the study of animal behavior, derived from the discovery of instinctive movements. Anticipating the modern viewpoint, Spalding, as early as 1873, proposed, on the basis of his experiments, that besides learned behavior there existed inborn behavior patterns, the "instincts." He kept nestling swallows in such narrow cages that they were unable to practice any flying movements. Nevertheless, these birds were able to fly excellently, on their first opportunity, when released at the age when swallows normally fly. Spalding's experiments were forgotten until Whitman (1899, 1919) and Heinroth (1911) independently called attention to these innate behavior patterns. Each of these authors explored the systematics of a group of birds—Whitman, the pigeons; and Heinroth, the ducks. Since morphological characters proved inadequate, they each sought other genetically constant characters upon which to base their classifications. They thereby discovered behavior patterns, such as courtship display movements, with specific taxonomic value.

Craig (1918), through his own researches, made the first step from the purely descriptive to the nomothetic stage, when he discovered a certain lawfulness in these fixed patterns of behavior. Lorenz (1935, 1937) developed these beginnings of Craig's further, and published the first general work program which led to further ethological contributions by other investigators. More and more, interest concentrated on these instinctive acts, which we will discuss later in detail.

The method of ethology is the same which every scientific discipline uses when exploring an organ or organism. It starts with the description of behavior forms, which leads to the systematic cataloguing of these forms, and may then proceed to a physiological causal analysis. The method of explanation includes both comparative morphology and physiology, the ultimate aim of which is the causal understanding of the observed regularities and lawfulness; but emphasis is placed on the evolution, ontogeny, and survival value of behavior.

Although classical physiology is today fully aware that there are various levels of integration and coordination, in the past this discipline concentrated mainly on the analysis of simple muscular contractions. The ethologist emphasizes these various levels of integration and tries to describe, analyse, and understand the lawful interplay and succession of very different muscle actions. The entire organism, rather than isolated nerve-muscle units within the organism, is the object of study. It is an approach which includes the relations of the organism to its environment (Ecology) and to the members of its own species (Sociology). The ethologist is particularly interested in the phylogenetic origin of the observed patterns of behavior, and tries to trace these by comparing related species. Indeed, it is this phylogenetic constancy, i.e., the presence of similar behavior forms among related species, which establishes the validity of the phenomena with which he deals.

Ideally, the start of any analysis is an inventory of innate behavior patterns, the ethogram, ob-

tained by observation of captive and free-living animals. Although recent ethological investigations, such as those of Marler (1956) on the behavior of the chaffinch and of Morris (1958) on the reproductive behavior of the ten-spined stickleback, sometimes begin this way, older ones often began with chance observation and subsequent interest in the origin or function of a particular animal movement.

The ethologist is interested in the survival value of observed behavior patterns, not with a view towards answering the finalistic question "for what?" but rather to understand in the service of which function selection pressure has determined the evolution of a certain structure. It should be pointed out that ethology does not restrict itself to the study of innate behavior patterns alone, as is sometimes critically implied. All ethologists are aware that in higher animals innate and acquired patterns of behavior are nearly always linked together in a unified functional system, which may be explored as isolated partial systems (both physiologically and psychologically) and as a single system (ethologically).

Behavioral phenomena have been generally considered within the province of psychology by American investigators, but all behavioral processes fall equally within the scope of physiological explanation. Whereas physiologists and psychologists, when dealing with animal behavior, have primarily emphasized reflex theory, conditioning, and learning, the positive contribution of ethology has been its emphasis and exploration of those mechanisms which are innate, i.e., those reactions and states within the animal upon which conditioning and learning depend.

Ethological investigation is concerned with the behavior of many diverse groups of animals, and its experimental tests are designed to explore specific aspects of behavior observed under natural conditions. In this it also differs from American psychology which confines itself to a few selected laboratory animals. Consequently, ethologists have refused the historical term "animal psychology," without in any way minimizing the individual contributions of this and other behavioral disciplines.

THE INSTINCTIVE MOVEMENTS

Many papers have confirmed the constancy of instinctive behavior patterns first demonstrated by Whitman and Heinroth. It is only necessary to mention a few of these studies—that of Lorenz (1941), dealing with the courtship postures of 16 species of ducks, of Crane (1949, 1952) dealing with courtship and threat display in 15 species of salticid spiders, and the defense display of 15 species of mantids, Baerends' and Baerends von Roon's (1950) cichlid studies, Fulton's (1932, 1951) studies of the songs of crickets and katydids, Jacobs' (1953) studies dealing with the stridulatory behavior of grasshoppers, and the detailed studies of Faber (1919, 1932, 1936, 1953) on grasshoppers over a period of three decades. In Great Britain, Sladen (1899, 1912) early utilized behavioral differences in his taxonomic studies of bumblebees; and in his taxonomic studies of termites and their nests, Emerson (1938, 1956) emphasized the biological significance of the study of the phylogeny of behavior. The fact that the instinctive behavior movements of all individuals of a natural systematic group (species, genus, family, etc.) expresses itself in the same way, suggested that the time sequence of the individual muscle actions involved in a movement is an inherited trait. Lorenz therefore termed these movements "fixed patterns" (Erbkoordinationen). These movements sometimes evolve phylogenetically more conservatively than morphological characters. The scratching movement with the hind leg found in all amniotes (reptiles, birds, and mammals) is one example (Heinroth, 1929), the synchronized wing-leg and double wing-neck stretch movements found among birds another (Fig. 1). A certain variability within the species derives from the superposition of fixed patterns (see p. 196) and especially by the fading of intensity, to which all such movements are subject. Some intraspecific variability may also be due to learning superimposed on an innate behavior pattern, as in the nut-opening technique of squirrels (see p. 199). There are all gradations from intention movements, which indicate what an animal "wants" to do, up to the fully executed patterns of behavior. A fixed pattern of behavior is frequently combined with a taxis, forming a natural unit which is designated the instinctive act (Instinkthandlung). [An instinctive act may include appetitive behavior and releaser mechanisms, as well as a taxis and instinctive movements.] The prey-catching reaction of a frog is composed, for example, of a directed orientation movement in line with the prey (turning towards it), followed by the fixed pattern, "snapping." The greylag

FIG. 1. INSTINCTIVE STRETCH MOVEMENTS

These fixed behavior patterns, found throughout the class Aves, are often performed soon after hatching. *a*, The beginning of the double wing-neck stretch in the Canadian Goose, *Branta canadensis*; *b*, the forelimbs of penguins have undergone considerable morphological modification, but as seen in this species of *Spheniscus*, the double wing-neck stretch is retained; *c*, double wing-neck stretch in immature Sheld-Duck, *Tadorna tadorna*. Leg-wing stretch movements are shown in *d*, the Bahama Duck, *Poecilonetta bahamensis*; *e*, the Sheld-Duck, in which the right wing has been clipped; *f*, the Crane, *Grus grus*; *g*, the Canadian Goose; and *h*, the Greylag Goose, *Anser anser*. (Photographs: S. Kramer.)

goose, *Anser anser*, which rolls a displaced egg back to the nest, prevents the sidewards rolling of the latter by following it with looping contact movements of the beak. If the egg is suddenly removed once the movement has started, the fixed pattern "egg-rolling" continues almost as a vacuum activity (Leerlaufreaktion). In the latter case, no sidewards balancing movements take place.

Experiments with animals isolated from members of their own species and deprived of other learning possibilities (Kaspar Hauser tests) have shown that these fixed patterns may develop independently of a specific pattern of previous reinforcement, i.e., learning. Grohmann (1939), without knowing of Spalding's experiments, raised pigeons in cages so small that they were unable to make any wingbeat movements. Nevertheless, these animals could fly as perfectly as the control animals which had the possibility of "learning" to fly. Whitethroats (*Sylvia communis*), which Sauer (1954) raised in isolation in soundproof chambers, developed all 24 species-specific calls, and the sequence of development in all these isolated birds was the same. Likewise, the sequence of species-specific behavior patterns associated with display and brood-rearing has proved to be innate in squirrels and hamsters raised in isolation (Eibl-Eibesfeldt, 1951b, 1953). In many behavior patterns of invertebrates, it is obvious that learning is excluded. Courtship behavior, which occurs on the first meeting of an adult male spider with a female in the requisite physiological state, inhibits their usual predator and self-protective behavior. In one species, at least, (*Eustiromastix* sp.), it undoubtedly prevents the male from being eaten by the female before copulation. In this latter case there is clearly no time for learning, and no evidence was found of display learning among other species (Crane, 1949). Therefore, these patterns are termed "innate," i.e., they are inherited and not learned as the result of imitation or exercise. This is not to say that external environmental stimuli play no role in their normal development. They certainly do so, but in the same way that they influence morphological structures. Just as the male mallard duck inherits its green head, a morphological character which develops as a releaser just before it is sexually mature, it also inherits its grunting whistle (specific behavioral character).

A good demonstration that behavior patterns can be inherited was recently given by von Hörmann (1955). She traced the inheritance of fixed behavior patterns by crossing two closely related species of *Gryllus* differing in four specific characteristics of their behavior. It was found that in three characters, the inheritance was monofactorial. Earlier, Fulton (1933, 1937) had shown the value of utilizing behavioral characteristics for interpreting the relationship of three ecological races of the cricket, *Nemobius fasciatus*. These races, *N. f. fasciatus* (De Geer), *N. f. socius* Scudder and *N. f. tinnulus* Fulton, showed no distinctive morphological characteristic, but possessed distinctive songs. Crosses between *socius* and other races gave no offspring, but those between *fasciatus* and *tinnulus* gave hybrid offspring from seven pairs out of eight. On maturity the hybrids proved to have an intermediate type of song which had never been detected in nature. Fulton concluded that these results indicated that the so-called races constitute natural groups which maintain their integrity in nature.

Observation of the intact animal shows that behavior is not always the response of a passive animal to an external stimulus. When in a state of special readiness to perform a specific activity, the animal often actively seeks a stimulus situation which will permit the performance of this behavior. Craig (1918) called this characteristic activity "appetitive behavior." The term appetitive behavior is not always used in the same way. Van Iersel (1953) termed all courtship behavior appetitive behavior for fertilization, as he considered fertilization to be the terminal consummatory act. Such a broad definition is of little value, as it includes fixed patterns, taxis, and learned behavior. The use of the term appetitive behavior is here restricted to the unoriented seeking behavior, as utilized by Roeder (1955). It usually brings the animal to a satisfaction.

[The goal of the animal is the performance of an act. The dog does not kill "in order" to eat—he may often kill independently for the satisfaction of releasing the innate movements of catching and killing.]

What factors are responsible for this special readiness to act? There are, of course, external factors which have proved to have a stimulating influence. Van Iersel (1953) showed that the eggs of the stickleback not only release fanning, but stimulate the broodiness of the male stickleback. Furthermore, there are inner sensory stimuli, for example, those reporting the state of a storage organ (stomach, bladder, intestine, etc.), which

can build up a certain appetitive behavior (food-seeking, or seeking for a place of defecation). Important inner stimulating factors are also the hormones (Beach, 1947, 1948), which, together with external stimuli, induce such phenomena as rutting behavior. With testosterone, for example, one can obtain sexual activity in vertebrates long before sexual maturity, or outside the normal sexual cycle. Progesterone specifically influences the nest-building behavior of female white mice (Koller, 1952). Hormones, it is known, have inhibiting influences as well as stimulating ones. Kilak and Beach (1955) have shown that estrogen inhibits aggressiveness in both sexes of the golden hamster. A real understanding, however, of the mechanism by which hormones induce or inhibit specific behavior is lacking.

Much has been written concerning hormonal influences on behavior, but relatively little attention has been given to those behavioral factors which influence hormone production. Lehrman (1958a, b) studied the effects of courtship and nest-building behavior on the induction of broodiness (egg incubation) in the ring dove, *Streptopelia risoria*. His experiments led him to conclude that participation in both courtship and nest-building brings about the physiological changes underlying the onset of the readiness to incubate. Subsequent comparison of the effects of progesterone and estrogen on incubation behavior with the effects of participation in courtship and nest-building led him to suggest that courtship stimulates estrogen secretion and that estrogen stimulates nest-building behavior, which in turn encourages progesterone secretion leading to incubation. These studies draw attention to the neglected fact that behavior exerts an influence on physiological processes and metabolism, as well as the other way around (see also Beach, 1948).

The main completely unsolved physiological problem regarding instinctive movements lies in the fact that there are lawful fadings of the inner readiness to act which cannot be explained by any of the above-mentioned factors. Thus Lorenz (1937) described that his tame, well-fed starling, which was deprived of normal fly-catching, reacted more and more unselectively to outside stimuli (lowering of threshold) with certain predatory activities and finally, if adequate stimuli (flies) did not appear for a long time, the whole sequence of fly-catching went off in vacuo. The starling suddenly flew up, snapped at nothing that could be seen, went back to his perch, performed a characteristic killing movement, and finally swallowed. Similar examples are given by Koenig (1953). On the other hand, increases of threshold, in which the fixed pattern is harder and harder to release, have also been observed. This spontaneity of behavior, known for many fixed behavior patterns, was interpreted by Lorenz (1937) upon the hypothesis that every instinctive act is fed by its own mechanism of excitation in the central nervous system. In this Lorenz was influenced by the papers of von Holst (1935, 1936, 1937) which demonstrated a central nervous system automatism for locomotion. Accordingly, while an inhibitory mechanism exists, preventing discharge, the excitation is built up in the central nervous system. When the specific stimulus situation is encountered, the inhibition is removed. The performance of the fixed behavior pattern uses, in part, the built-up energy and hence the concept of the "consummatory act." In which way, and specifically what is stored and consumed, is still completely unknown. One can think of biochemical processes through which a higher energy level is built up and discharged roughly comparable to the processes in working muscles. As will later be pointed out, there are also neurophysiological results which confirm spontaneity in the central nervous system.

By special experiments on intact animals, Drees (1952) and M. Schleidt (1955) have shown specific central nervous fatigue of fixed behavior patterns. Nevertheless, a fixed behavior pattern does not end by complete exhaustion of the central nervous mechanism—it normally ends through the performance of the act which activates a special switch-off mechanism. The consummatory stimuli can be initiated by the proprioceptive system as well as by other sensory organs, as has been suggested by Bastock, Morris, and Moynihan (1953). In many rodents, for example, escape reactions come to an end when certain stimuli of the shelter, such as darkness and smell are reached (W. M. Schleidt, 1951), and certainly not as a specific central nervous energy is used up. Prechtl (1953), in studying the gaping reaction of song birds, Franzisket (1953) the wiping reaction in the hindleg of the frog, and M. Schleidt (1955) the gobbling reaction of the turkey, all found evidence of fatiguing in places other than the motor center. For example, M. Schleidt was able to show that when the gobbling reaction was repeatedly released by a certain tone, the turkey stopped reacting, but immediately continued when another

tone was used as a stimulus. This indicated that the motor center was not exhausted, and as she could exclude specific adaptation of the sense organ as well as a learning process as a possible explanation, she termed this special process afferent throttling (afferente Drosselung). Prechtl and Franzisket had previously shown similar phenomena, which the former termed adaptation and the latter termed afferent fatigue.

NEUROPHYSIOLOGICAL CONSIDERATIONS

There is considerable controversy regarding the elementary processes in the central nervous system, upon which fixed patterns of behavior with the above described properties can be based. Many still cling to the reflex-hypothesis explanation of all behavior, which Lorenz discarded in 1937. Therefore, in what follows, certain neurophysiological facts will be presented in brief, and their relationship to fixed patterns of behavior will be discussed.

According to the classical reflex theory all behavior is a response to external or internal sensory stimuli. An afferent nerve receives a stimulus from its sensory end-organ and carries the excitation to the spinal nerve cord, whose gray substance forms a "reflex center." Here the excitation is transferred to an efferent nerve. These three elements comprise the so-called "reflex arc." More complicated behavior patterns are nothing more than chain reflexes. When an eel swims, according to this theory, the contraction and relaxation of one segment mechanically stimulate the proprioceptors of the following segment, and these, in turn, stimulate the reflex arc which leads to the contraction of this succeeding segment.

Even at an early date there were findings which could not be put into this scheme without constraint. Graham Brown (1912) discovered that in a decerebrated cat two completely deafferentiated antagonistic leg muscles made rhythmical contractions. This led to the conclusion that there exists an endogenous automatism of the central nervous system independent of external stimuli. Weiss (1941) implanted a piece of embryonic spinal cord and an embryonic limb bud in the axolotl. This implant becomes innervated in the course of its development by the implanted embryonic spinal cord. In this process, the motor neurons grow faster than the sensory neurons, and reach the leg before the latter. At the moment that the efferent connection is made the leg starts to move. Although these movements were not completely coordinated walking movements, nevertheless, they showed the primitive form of coordination involving the alternate contraction of antagonist muscles. This, too, demonstrated the endogenous automatism of the central nervous system. This automatism has also been demonstrated by electrophysiological methods. Adrian and Buytendijk (1931) found in the isolated brain stem of the goldfish rhythmical electrical discharges which corresponded exactly with the frequency of breathing movements (movements of the operculum). Roeder (1955), who demonstrated spontaneous activity in the isolated ganglia of the cockroach, refers to a number of additional examples of automatism.

Von Holst (1953) has pointed out that our present knowledge of the relation of the central nervous system to the peripheral senses and muscular movement is meager in comparison to what is *not* known. The method utilized in such investigations determines in large part the extent of our knowledge and the nature of our conceptions. Heretofore, the most popular method consisted of artificially inactivating the central nervous system and then, through peripheral stimulation, evoking a peripheral response. It is largely on the basis of this one-sided methodology that the central nervous system is held to be only a reflex mechanism.

Rather than making exclusive employment of a methodology which begins with peripheral stimuli, von Holst (1935a,b, 1936, and 1937) has centered his experimental investigations on the central nervous system itself. He demonstrated that in the isolated ventral nerve cord of the earthworm there are salvos of rhythmical impulses exactly corresponding to the contraction of segments in the normal creeping movements of this animal. Earlier, he totally denervated a section of an eel so that this section could no longer contract. The wave of movements which began in the head region disappeared in this denervated segment, but it appeared again in the region behind this area, completely coordinated at the correct phase. The same was observed when a section was mechanically fixed. The process of coordination in such locomotion, therefore, takes place through the spinal nerve cord, but not as a result of "chain reflexes."

Similar phenomena have been demonstrated in other vertebrates. Tadpoles, in which the dorsal roots of the spinal cord were destroyed, were able to swim (Weiss, 1941). Deafferentiated tenches could swim in a coordinated manner as long as two

nerves from the spinal roots innervating the pectoral fins remained intact. The same applied to the "spinal" dogfish (von Holst, 1936; Lissmann, 1946). A completely deafferentiated toad is able to swim in a coordinated fashion, according to Gray and Lissmann (1940), as long as both labyrinths are intact. After removal of both the labyrinths it was no longer able to do so. Here, a minimum afferent input appears to be necessary, but "chain reflexes" are likewise inadequate for the explanation of the locomotory pattern in these cases. It has been suggested that a certain input of sensory excitation may either remove an inhibiting mechanism or may raise the general level of central nervous excitation—we do not know.

In the relative coordination movements of many animals, including invertebrates and vertebrates, as well as man, there are central regulating mechanisms which lead to the final action. The fact that in certain situations, as for example, in motion, the "optomotor reflex" or the "postural reflexes" no longer operate, has been explained by classical reflex theory with the assumption that these reflexes are inhibited or blocked during motion. These assumptions, to which reflex theory frequently takes recourse, have largely gone unchallenged. Von Holst and his colleagues have succeeded in showing, however, that it is possible to subject such conceptions to experimental investigation.

Let us take two examples. Mittelstaedt (1949) has shown that if the fly *Eristalis* is placed in a striped cylinder, and the cylinder is rotated to the right while the insect is at rest, the fly changes its position by likewise moving to the right (Fig. 2a).

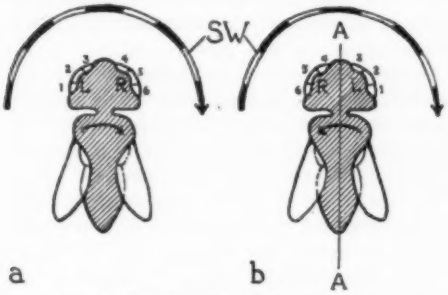

FIG. 2. THE TURNING RESPONSE IN THE FLY, *Eristalis*

a, Normal animal; *b*, animal after rotation of the head 180° around the axis A-A. R, L, right and left eyes (the ommatidia are schematically numbered). The arrow in the animal, around which a striped cylinder SW is moved to the right, indicates the direction of its active turning response. (After Mittelstaedt, 1949.)

This response has been termed the "optomotor reflex." If the fly begins to move spontaneously in such a cylinder, it no longer responds to the changed position of the stripes. In the latter case this reflex does not interfere with the fly's movements. According to reflex theory the optomotor reflex is inhibited during locomotion. Mittelstaedt succeeded in rotating the fly's head 180° around its axis and fixed it in this position, so that the right and left eyes were reversed (Fig. 2b). If the cylinder is then moved to the right while the insect is at rest, the fly responds by moving to the left. Theoretically, if the fly now begins to move spontaneously, it should move unhindered by any "optomotor reflex." Actually, however, when the fly begins to move spontaneously, it now moves alternately to the right and left in small circles until exhausted. The assumption that the optomotor reflex is inhibited during locomotion is clearly contradicted by this latter experiment.

The utricular statolith in the labyrinth of vertebrates is influenced by gravity. As von Holst et al. (1950) have demonstrated, if a passive fish resting in its normal position is tilted, say to the right, the increasing shearing force of the statolith on the sensory surface of the labyrinth on this side results in increased activity in the postural center of the central nervous system, and this sets in motion the motor movements that bring the fish back to its normal position. Under such experimental conditions this postural reflex works untiringly. During the normal activity of the fish, as in the search of food, however, spontaneous tilting movements frequently take place. Why, in this case, does the postural reflex fail to pull the fish back automatically to its normal position? According to reflex theory, the postural reflex is blocked during spontaneous movement. It can be shown by experiment that this is not the case. By placing the fish in a constant centrifugal field, it is possible to double the shearing force which the statolith exerts on the sensory surface of the labyrinth. Now, if one measures the frequent, spontaneous tilting movements which the free-swimming fish makes, one finds that they have decreased in magnitude, and that the tilting movements become less the heavier the statoliths are made. Thus, the righting reflex is not blocked during spontaneous movements, but is dependent upon or regulated by the afferent feed-back which they cause.

These, and a number of similar phenomena and experiments provide the basis of the reafference

principle which von Holst and Mittelstaedt (1950) have suggested as a more accurate explanation of what takes place. In brief, this principle may be stated as follows: the sum total of all impulses produced by stimuli in any receptor are referred to as the *afference*, and the whole of the motor impulses as the *efference*. Afferent stimuli, however, may have two different sources: those produced by external energy changes, or the *ex-afference*; and those produced by internal energy changes in the muscular system, or *re-afference*. If we abandon the concept that all muscular activity is initiated by ex-afferent stimuli, we may now ask: "What takes place when efferent stimuli emerge from a particular motor center?"

According to this principle, each command, or fixed alteration of the impulse stream descending from some higher center *Zn* (Fig. 3) in the central nervous system to a motor center Z_1, causes here an efferent impulse, *E*, which gives rise to an activity change in the ganglionic mass, which is termed the efference copy, *EK*. The efferent impulse, *E*, induces not only the movement in the motor end organ, but also a reafference from that end organ, *A*, which returns to the motor center. The actual movement of the end organ is regulated by the reaction of the efference copy *EK* with the returning reafference, *A*. If we arbitrarily denote the value of the efference and its copy by a plus (+) sign, and the reafference by a minus (−) sign, the command descending from *Zn* flows out unhindered, and gives rise to constant efferent impulses, *E*, when *EK* and *A* exactly nullify each other. But if, as a result of some external influence, the total afference is too large, or too small, there remains in Z_1 a (+) or (−) residue. This residue continues upward to a higher center, or centers, as a report *M*, which may decrease or strengthen the initial descending command. This in turn modifies the efference emerging from the motor center Z_1. In this scheme, the (+) or (−) residue in Z_1, which continues flowing as a report, and originates as a result of outside influence via proprioceptors or exteroreceptors, is an *exafference*.

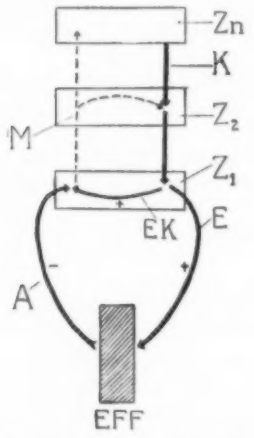

FIG. 3. ILLUSTRATION OF THE REAFFERENCE PRINCIPLE
See text for explanation. (After v. Holst and Mittelstaedt, 1950.)

The reafference principle not only enables one to predict the magnitude and direction of movement which an outside influence will exert on behavior, but it provides insight into known phenomena which have hitherto lacked an explanation. The visual phenomena which relate to space constancy may be included here. For example, whether a car moves across our field of vision, or we rotate our head or eyes about a car which is standing still, the image of the car moves across our retina in both cases. Only in the former case do we see a moving car—in the latter case we have a phenomenon known in the field of psychology as "space constancy." It is known, from cases of people in whom the eye muscles are paralysed (this has also been demonstrated by experiment), that every impulse to move the eyes, say, to the right (which cannot be carried out) results in the objects in the field "jumping" to the right. Since nothing has actually moved this is clearly an "hallucination," but it demonstrates the fact explainable by the reafference principle, that as a result of an unmatched efference copy an intended but unfulfilled movement may cause a perception.

Von Holst has emphasized the fact that the reafference principle is not meant to explain *all* phenomena in the central nervous system, but can in predictable fashion explain certain phenomena which reflex theory explains erroneously. It is only one of many central nervous mechanisms. Here it need only be mentioned that it illustrates in precise manner the errors that may arise if we insist upon explaining behavioral data from one area of investigation with as yet limited theoretical constructions in the field of neurophysiology. As von Holst has indicated, until our knowledge of central nervous mechanisms is more adequate, each field must be left to develop along its own lines. Behavioral data, which do not fit into existing

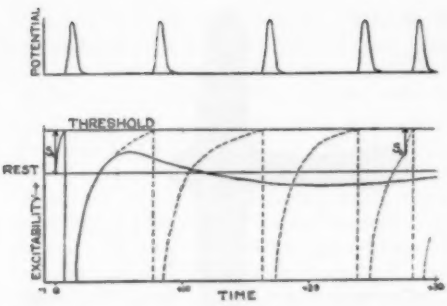

FIG. 4. EXCITABILITY CHANGES IN STABLE (STIMULUS-RESPONSE) AND UNSTABLE (SPONTANEOUSLY ACTIVE) NEURAL ELEMENTS

(Lower graph) Solid curve represents excitability sequence in elements such as mammalian A fibers following stimulus S_1. Broken curve represents predicted excitability sequence in elements with a lower threshold and, hence, repetitively active following stimulus S_1. S_2 is the stimulus interpolated at some point in the spontaneous excitability change, causing premature discharge. (Upper graph) Nerve impulses that would arise from the excitability changes shown below. Time units would have different values for different types of excitable tissue. In the case of mammalian A fibers the units would be milliseconds. (After Roeder, 1955.)

neurophysiological theory, provide us with extremely valuable focal points for further investigation.

The spontaneous activity which has been demonstrated in isolated parts of the central nervous system certainly provides some basis for spontaneous behavior of the intact organism. Roeder (1953, 1955), who taught neurophysiology on the basis of reflex theory for many years, has recently arrived at the same conclusion, after seeing the complete inadequacy of the reflex theory for explaining certain phenomena in the behavior of insects. Roeder has suggested that those individuals who attempt to present ethology, together with its concept of endogenous activity, as a vitalistic philosophy should read the voluminous literature on the physiology of the heart, "a spontaneously active, but certainly not a supernatural organ."

Roeder has indicated that existing neurophysiological findings support the concept of spontaneous activity. He, too, pointed out that in the neural elements underlying spontaneous and reflex behavior only gradual differences exist as regards their threshold of excitability. His theoretical explanation is as follows. In the stable neurons, the excitability remains at a constant resting threshold. A stimulus is necessary to bring the excitability to the level of discharge. After discharge the excitability falls to zero, gradually rises again, and briefly passes the resting threshold ("phase of higher irritability"), then again falls to the normal resting threshold (see Fig. 4). In the unstable neurons the excitability, and with it the readiness for response, builds up until the threshold of release is reached by itself and a spontaneous discharge takes place. Between the extremes of these two types of neural elements, there are all gradients. Whenever the physiological state of an organism causes the resting and response thresholds to become approximated (and this has actually been accomplished in varied ways experimentally) one stimulus may lead to a self-perpetuating sequence of discharges as the curve in the phase of higher irritability will repeatedly reach the releasing threshold.

Actually, very little is known about the anatomical basis of the "centers" responsible for fixed patterns of behavior. We know that coordination in the spinal cord is based on the interaction of unstable cells, which are often far from each other. The coordination apparatus would therefore seem to be little "centralized." Those "centers" which have been localized until now, through destruction or stimulation of parts of the central nervous system (Aronson and Noble, 1945; Huber, 1955; etc.) may be considered as initiating areas. Such initiating areas have been demonstrated by Hess (1948) and Hess and Brugger (1943), who drove fine electrodes into the diencephalon of otherwise intact cats and with simple electrical impulses were able to release highly integrated fighting, threatening, sleeping, eating, and defecating responses together with appropriate appetitive behavior.

Another important approach to an understanding of the central nervous system was made by Coghill (1929, 1933), who utilized the embryonic behavior of *Amblystoma* as a clue to the functional development of the neuromuscular system. It was Coghill's conclusion that the developing pattern of embryonic behavior in vertebrates consisted of the expansion of a growing, primarily integrated, total pattern of action. Within this total pattern, partial patterns, such as reflexes, arise later in development by individuation, through restriction of both the field of motor activity and the field of adequate stimulation. It is in a field of almost total inhibition that the local reflex emerges. Since inhibition is an active process, the mechanism of the total pattern participates

in every reflex. The fallacy of the traditional conception of the chain reflex, that one initial reflex stimulates the next in series, and this the following, etc., became more apparent, Coghill felt, when one studied the ontogeny of behavior.

Spontaneous activity is a familiar phenomenon to the vertebrate embryologist who observes behavior. *Myogenic activity*, which originates within the muscle tissue itself, spontaneously and usually rhythmically, occurs not only in the developing heart but also in the trunk musculature of certain vertebrate embryos. Since motor neurons usually establish functional connections with their muscles before their sensory connections are established, one also observes *neurogenic activity* of muscles due to discharge of the motor neuron, either spontaneously or under the influence of stimuli from outside. *Reflexogenic activity*, in which a receptor sensory neuron, one or more intercalated neurons, and an effector motor neuron are involved, only occurs relatively later in development (Hooker, 1952).

The results of these diverse investigations amply confirm the fact that our present knowledge of the relation of the entire organism to the central nervous system, and in turn the relation of the central nervous system to muscular movement and behavior, is far from complete. We require fuller knowledge of the many behavioral responses of which the animal is capable, if our neurophysiological explanations are not to remain restricted to isolated, special systems within the animal.

THE INNATE RELEASING MECHANISM (IRM)

The conception of a continuous production of central nervous system excitation, normally blocked by another inhibitory mechanism, led to the assumption of a special afferent apparatus which removes this inhibition at the biologically appropriate moment. With the arrival of a specific key stimulus the innate releasing mechanism opens the way for the above impulses to their appropriate motor organs. Although these key stimuli are, as a rule, quite simple, they normally characterize the biologically adequate situation in unmistakable fashion. We can often ascertain such stimuli by experiments with dummies. If a bundle of red feathers is presented to a male robin (*Erithacus rubecula*), it will immediately attack this crude dummy, while it would ignore the stuffed skin of a rival male from which the red breast feathers had been removed (Lack, 1943). Sometimes the animal reacts to configurational properties or "Beziehungsmerkmale." A flight silhouette of a predator bird cut out of cardboard has a flight-releasing effect only when moved in one direction (Tinbergen, 1948). When moved in the opposite direction it has no effect at all (Fig. 5). To the human observer, such a silhouette appears more like a flying goose than a bird of prey, when the direction of movement is reversed. Often several key stimuli work together. In such cases, each of these stimuli are capable of a releasing action, but the effectiveness of a dummy proves to be proportional to the sum of the stimuli used (Seitz, 1940). Such innate reactions are differentiated from learned or conditioned responses which are released by complex stimulus situations. If something is changed in such a learned "Gestalt" the animal has to relearn the new situation. Tame birds become shy when the investigator or keeper wears glasses for the first time, or changes his usual clothing.

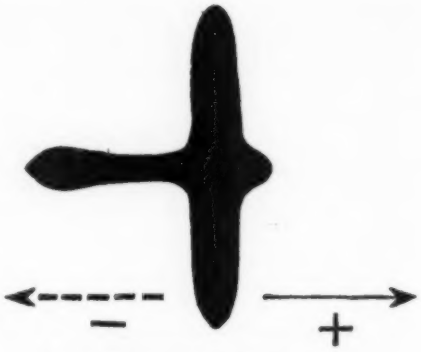

FIG. 5. EXPERIMENTAL MODEL USED TO RELEASE ESCAPE REACTIONS

Model of bird of prey releases escape reactions (flight) among young gallinaceous birds, ducks and geese when moved to the right. Moved to the left (broken arrow) it has no releasing function. In this case shape in relation to the direction of movement provides the active sign stimulus. (After Tinbergen, 1948.)

When referring to innate behavior patterns and innate releasing mechanisms, the term "innate" includes two different concepts. In the first case it indicates that such a motor pattern was not learned by exercise, and in the second case that the reaction to the stimulus was not conditioned.

The innate releasing mechanism has been defined in purely functional terms. Its neurophysiological basis remains unknown. We will deal with the behavior patterns of structures which have been developed for a releasing function (so-called

"releasers") in more detail below. It might be appropriate at this point, however, to draw attention to two types of errors made in behavioral explanations. The first of these consists of the use of isolated neurophysiological data as a general explanation of all behavior. On the other hand, investigators familiar with specific behavior patterns have as often interpolated existing neurophysiological data towards the explanation of such behavior. In both instances the link between the two types of data, valid as each may be in itself, is frequently not established.

The increased selectivity of the innate releasing mechanism by learning processes

The specificity of such releasing mechanisms varies greatly. Often an animal reacts unselectively to a few key stimuli. In the common toad (*Bufo bufo* L.), for example, nearly every object between 2 mm. and 20 cm. in length releases prey-catching behavior. Moving pebbles, pieces of wood or paper, flowers, etc., are snapped at by young adults as if they were insects or worms. The upper size limit of such prey may vary. With larger objects the direction of movement often decides what the toad will do. If the object moves towards the toad, the toad will flee; but the toad will follow the same object if it moves away.

The wide variety of objects towards which an innate releasing mechanism will be directed also becomes selectively narrowed through learning. After negative experiences with unpalatable food, the toad quickly learns to avoid such objects (Eibl-Eibesfeldt, 1951a). Polecats follow and bite every fleeing object which is smaller than the animal itself. For example, they attack a fleeing rat immediately, but if the rat sits quietly in a corner the polecat merely sniffs at it curiously. If the rat runs towards it, the polecat runs away. But after one rat-killing experience, it will recognize and attack a rat under any circumstances. The orientation of the killing bite to the neck of the prey is also learned. The inexperienced polecat grasps the prey at various parts of the body, but is successful only if it grasps the neck, and this it learns in a few trials (Eibl-Eibesfeldt, 1957b).

Imprinting

Imprinting, which is one form of conditioning, may be to some extent considered as an unselective innate response which becomes directed towards a specific object. It resembles the above-mentioned narrowing down of an innate response through learning, but differs in at least one, or sometimes two important points. First, such imprinting takes place during an extremely short sensitive period in the life of the animal. Newly hatched goslings from an incubator immediately follow the human being who is their keeper and stick to this human object relationship. If they have once followed him for a few hours, they will then refuse to follow their own mother, no matter how often they are placed together with her thereafter (Lorenz, 1935). Hess (1955) has shown that imprinting in the Mallard is restricted to the period between 12 and 17 hours after hatching. Lorenz (1955) allowed a greylag goose (*Anser anser*) to raise Muscovy ducklings (*Cairina moschata*) as her own young. After five weeks he separated the ducks from the goose. Although from that time on the Muscovy ducks showed special reactions only to the members of their own species, with the onset of sexual maturity they chose greylag geese for sexual partners, thus proving to be imprinted to the latter. Fabricius (1951) has carried out additional extensive studies on imprinting in anatids. Similar imprinting phenomena are known for mammals (Grabowski, 1941).

The second characteristic which sometimes distinguishes imprinting is its apparent irreversibility. In certain instances it has been shown that if a behavior pattern is once fixed to a given object, this object fixation persists. It is possible for an imprinted animal to react to a substitute object, but in a situation of choice, it will prefer the object to which it has been imprinted. Hellman (cit. by Lorenz, 1955) raised budgereegahs artificially. When these birds became sexually mature he enclosed them in a covered cage, so that they could not see their keeper. The birds paired, brooded, and cared for their young, but when Hellman, together with Lorenz, uncovered the cage, both animals showed courtship display towards these men. Thereafter, they no longer showed pairing behavior towards each other, and neglected the care of their young.

Betrothal ceremonies are performed by juvenile bullfinches (*Pyrrhula pyrrhula* L.), as a rule between siblings of the same nest. Sooner or later these sibling betrothals are dissolved, each partner finding a new mate of the opposite sex, even if the original sibling pair was a homosexual one. Bullfinches reared in isolation usually accept the human keeper as a substitute for their sibling partner. If, during autumn and winter, the bird

finds opportunity to make the acquaintance of a conspecific of the opposite sex, its relation to the human gradually dissolves and normal betrothal takes place. If, however, the bird continues in human company during this period, it later accepts a human being as a permanent mate, and it is only then that the sexual imprinting to humans becomes irreversible (Nicolai, 1956).

Hinde, Thorpe, and Vince (1956), studying the following responses of young coots (*Fulica atra*) and moorhens (*Gallinula chloropus*), were able to show that this response can be released by a number of objects quite different from each other in size and shape (viz., model of moorhen, black box, small colored ball, colored hides, man, etc.), but having in common the character of being in motion. The response takes place independently of any prior learning. "Imprinting" occurred when the birds followed the moving object and was not dependent on brooding, feeding, or any other activity normally directed by the parent to its young. These birds, however, could be trained to follow different models on successive runs—and it appeared that birds trained on one model would generalize to others presented in the same circumstances throughout practically the whole period in which they would follow at all. The investigators suggested that this response is "self-reinforcing" and that learning occurs when the birds maintain, by means of locomotion, a more or less constant spatial relation with a moving object. As a result of these experiments they concluded that the learning process in the following response of coots and moorhens was not irreversible, and that there was no evidence that imprinting in these cases was fundamentally different from other types of learning. The effects of this type of imprinting on adult behavior was not studied in these experiments.

Other types of restricted learning periods

There are certain forms of learning processes which have in common with object-imprinting the restriction to a definite sensitive period, which is often considerably separated in time from the effective demonstration of what has been learned. Heinroth (cited by Lorenz, 1955) once made a tape-recording of Blackcaps (*Sylvia atricapilla*) which he kept together in a room with 12-day-old nightingales for one week in May. At that time the young nightingales were only able to give a begging call. But when they began to sing in January, much to Heinroth's surprise, they showed a song which was in every detail comparable to the recording of the Blackcap song.

Utilizing a sound spectrograph, Thorpe (1954) studied the song-learning process in the chaffinch (*Fringilla coelebs*). In the first series of experiments, birds, which were reared normally by their parents, were isolated from them from their first September onwards. Such birds acquire normal songs when isolated from sight of other singing chaffinches, or even when subject to an overwhelming barrage of alien songs of other birds. They attend only to the normal song of their own species, which they hear outside. In this lack of general imitation the chaffinch differs from the bullfinch (*Pyrrhula pyrrhula*) and the greenfinch (*Chloris chloris*), which can learn complete songs from alien species. If such birds, isolated as juveniles, are prevented from hearing all bird song from September until May, but are allowed to hear each other, we find some difference between their songs and those in the first series of experiments. The first two phrases of their song are practically normal, but there is a slight tendency for the third phrase to be abnormal.

In the third series of experiments, birds which have been hand-reared and completely isolated from experienced singers since the first few days of their life show a song in which the first two normally distinct phrases are inseparable, the first half of the third phrase is always lacking, and the second half of the third phrase is either lacking or curtailed. The difference between the second and third groups of birds is explicable, according to Thorpe, only on the basis that some characteristics of the normal song have been learned during some sensitive period in early youth, before these birds are themselves able to produce any kind of full song. Thorpe concluded that the normal chaffinch song of three phrases has a very restricted inborn basis, amounting to little more than the ability to produce a song of normal length (2.3 seconds), and that the refinements have to be learned. Nevertheless, the innate basis of this song is sufficiently selective to ensure that the bird does not normally acquire notes or songs from any species other than its own.

THE RELEASER

Hand in hand with the development of selective receptive apparatus (the innate releasing mechanism), the corresponding signaling apparatus has evolved. These so-called "releasers" regulate intra-

specific behavior as well as other interspecific forms of communication (for example, in symbioses).

Very different things may serve as releasers. Often morphological structures are developed as signals, such as the nuptial plumage of male birds and the courtship colors of lizards and fishes. As these optically effective releasers are easily imitated with dummies, we have learned a great deal concerning them (Tinbergen, 1948). In these studies the previously mentioned law of heterogenous summation was discovered. These morphological signals also presented investigators with the possibility of creating supernormal objects. Such investigations revealed that the stimuli which

FIG. 6. CEREMONIAL FIGHT OF MALE MARINE IGUANAS, *Amblyrhynchus cristatus*
a, The animals try to push each other from a given spot with their heads. They neither bite nor cause injury but simply pit their strength against each other. *b*, The weaker one assumes a submissive posture by throwing himself flat on his belly. The winner (right) then stops fighting and waits in a threatening posture for the departure of his rival. (Photographs: I. Eibl-Eibesfeldt, Galapagos Islands.)

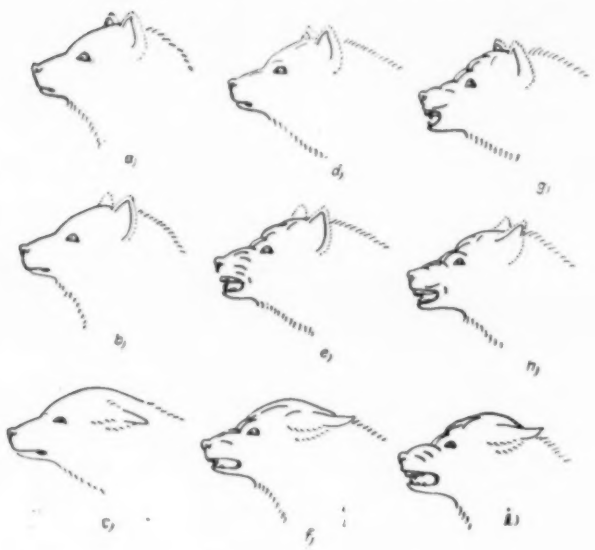

FIG. 7. EXPRESSION IN THE DOG

As the result of the superposition of three intensities of fear with three intensities of aggression, nine different expressions may be seen in the dog. Maximum fear, *c*, is expressed by pulling back the ears and the angle of the mouth; maximum aggression, *g*, is expressed by opening the mouth raising the upper lip and wrinkling of the snout and forehead. (After Lorenz, 1953.)

normally release a specific behavior are not always the stimuli with the optimal releasing function. Very often in such dummy experiments the natural stimulus situation is passed by in favor of the supernormal artificial object. Koehler and Zagarus (1937) found that ringed plovers prefer heavily contrasting, artificially spotted eggs to their own, which are lightly spotted. Similarly, Magnus (1954) succeeded in constructing supernormal ("überoptimale") female dummies of the butterfly *Argynnis paphia*. The innate releasing mechanism therefore proves to be open to exaggeration in a given direction, which is certainly of the greatest importance for the evolution of releasing structures (for example, in sexual selection).

Besides these morphological characters, chemical substances may also act as releasers. In the newt (*Triturus*), species-specific odors release the courtship display of the male (Zippelius, 1948). Many symbionts recognize the host by its odor (Davenport, 1955), and in many social fishes, as well as in tadpoles, there exists a chemically released flight reaction (von Frisch, 1941; Schutz, 1956). A chemical substance isolated from virgin females of the cockroach, *Periplaneta americana*, will cause courtship and copulatory behavior among the males (Roth and Willis, 1952).

Very often behavioral traits, keyed to various sensory organs of the partner, serve as releasers. Crickets, grasshoppers, frogs, birds, and many other animals locate their partners by species-specific calls. In anurans the recognition of sex and the synchronization of spawning and ejaculation are mainly based on tactile stimuli (Eibl-Eibesfeldt, 1955c). Threatening postures and many movements involved in courtship are optical releasers. Expressive movements also attain a high degree of differentiation in invertebrates, particularly in bees (von Frisch, 1950). Various reports on the social function of releasers have been published recently (Tinbergen, 1948; Eibl-Eibesfeldt, 1956a). These not only release behavior, but may have an inhibiting function under certain circumstances. In wolves, the defeated wolf exposes the part of his neck in the region of the jugular vein to his opponent, which inhibits all further attack of the aggressor immediately (Lorenz, 1943). In marine iguanas the ceremonial fight is ended when

the weaker one assumes the submissive posture of lying flat on his belly, which is the opposite of the threatening posture high on its legs (Fig. 6).

Through superposition and combination of a number of expression movements with different intensities, many degrees of expression are possible. Three intensities of flight reaction, combined with three intensities of aggressive expression, give nine possible mimic expressions in the dog (Lorenz, 1953) (Fig. 7). By various combinations of call signals, the bearded tit (*Panurus biarmicus* L.) has a multitude of expressions at its disposal (Koenig, 1951). Polecats are able to combine movements which express a readiness for social contact with repelling movements. Thus a pregnant female makes biting intentions toward the male, but at the same time utters a call which normally invites social contact. In this way she repels him, but appeases any aggressiveness which biting movements alone would provoke.

Innate expression movements also play an important role in human beings. Human mimic responses have been shown to be akin in all races, although sometimes varying in degree. Smiling, crying, and fear are such basic expressive patterns, which are present in the newborn infant (Ahrens, 1953; Koehler, 1954a). Some expression movements of man can be derived from intention movements, as has been shown by Darwin (1872) and discussed in greater detail by Lorenz (1952).

Innate expression movements regulate not only intraspecific, but interspecific, contacts as well. Predators are often driven away by certain threatening gestures. Social contact is initiated in certain marine fishes which invite cleaning behavior on the part of their symbiont fish. Other gestures result in the withdrawal of the symbiont fish (Eibl-Eibesfeldt, 1955b).

A series of recent papers is concerned with the question of the phylogenetic development of expression movements. Lorenz (1941, 1951) first pointed out that certain intention movements, as well as various behavior patterns characteristic of conflict situations (displacement activities), may evolve into expression movements, provided that they do so with sufficient regularity to characterize these states. One movement in the courtship of different species of male ducks undoubtedly evolved from displacement preening in this way. In the male Mallard these movements are not very much ritualized. He simply puts his bill between his wing feathers as if he were about to clean them. In the male Mandarin duck, with an identical cleaning movement, a bright orange feather is touched. In a similar way the male Garganey (*Anas querquedula*) points to and exposes a conspicuous group of wing feathers. In like manner, intention movements of aggression have evolved into threatening expressions.

Expression movements can derive their phylogenetic origin not only from instinctive movements but from practically all noticeable phenomena accompanying certain internal states of excitation such as those vegetative epiphenomena responsible for the erection of hairs and feathers, trembling, blushing, urinating, secreting, etc. These latter types of expression may undergo differentiation similar to those derived from instinctive movements. This differentiation always tends to increase the effect of these movements as signals. Frequently this is attained by the help of special morphological structures, as the development of scent glands, special behavior patterns developed in connection with territory-marking with urine or feces, vascularization of hairless body areas, etc. Accompanying, uncoordinated movements, such as trembling, can give rise to new instinctive movements through a process of ritualization. The tail-shaking movements of many rodents offer an example. The hissing sounds produced in defensive threat by so many lung-breathing vertebrates probably originated by a ritualized "mimic exaggeration" of breathing movements, whose increase in depth and frequency is primarily an unritualized epiphenomenon of high excitation (Morris, 1956; Eibl-Eibesfeldt, 1956a).

Insects provide a number of excellent examples of the evolution of secondary biological signals. Luminescence is an accompaniment of a specific metabolic process which occurs among many insect and other animal groups. Among fireflies (Lampyridae) it has secondarily evolved into a mating signal, and Barber (1951) has shown that in 19 species and varieties of North American forms belonging to the genus *Photuris* the male flashing behavior is species-specific. In the females of some fireflies and mycetophilid larvae it has apparently evolved into a prey-luring signal as well. The flight tone (wingbeat frequency) is likewise a secondary accompaniment of flight in insects. It has been shown, however, that among many species of *Drosophila* the flight tone is species-specific (Reed, Williams, and Chadwick, 1942), and in mosquitoes the wingbeat frequency

has evolved into the means whereby the male of a given species locates the female (Kahn and Offenhauser, 1949).

The specific problem of how the various physiological mechanism underlying the above fixed behavior patterns have become integrated into a unified system, in the course of their evolution, has remained relatively neglected. Ethological investigation has helped to focus attention upon just such problems. Thus, for example, the evolution of flight in orthopteroid insects is dependent, in part, on the evolution of a musculature with sufficiently high metabolic activity to be capable of the rapid contraction and sustenance necessary for flight. The further evolution of the flight mechanism, as evidenced in such advanced fliers as wasps, bees, and true flies is dependent, in part, on the development of an "asynchronous" flight musculature (capable of a contraction rhythm of up to a thousand contractions per second in the midge *Forcipomyia*; Sotavalta, 1953), which is not wholly dependent on the arriving nerve impulses (Roeder, 1951). The gradual increase in wingbeat frequency which takes place during the first week of adult life in the fly *Phormia* is correlated with a gradual increase in flight muscle cytochrome c and the size of the sarcosomes (Levenbook and Williams, 1956). By utilizing comparative methodology in analyzing the morphological, biochemical, and flight behavioral changes in 18 species of cockroaches, it can be shown that the loss of flight which occurs independently among many genera is accompanied by the ontogenetic failure to develop the pigmented musculature (cytochrome c) and correlated higher muscle metabolism associated with the function of flight (Kramer, in press). Comparative behavioral studies, thus seen, offer a rich and valuable starting point for further physiological investigation.

THE HIERARCHICAL ORGANIZATION OF BEHAVIOR

Observation shows that there are certain lawful relations between different motor patterns. Groups of instinctive movements appear together in a certain situation—they characterize a certain "mood" and show a common fluctuation of threshold. The fatiguing of a behavior pattern *A* also raises the threshold of a behavior pattern *B*, and vice versa, which indicates that both are somehow dependent on a common functional "center." Kortlandt (1955) called such charging "centers," and those locomotor patterns dependent upon them, instincts. If one observes certain complex behavioral patterns one sees a certain regularity in the sequence of instinctive movements. The "ritualized" fighting among conspecific individuals of cichlid fishes, which establishes the spacing of territories, may be taken as an example. Intimidation displays precede most fighting in many bony fishes, and in cichlids a series of differentiations of these intimidation displays can be shown to have taken place. In genera like *Haplochromis*, a furious and damaging fight follows a very short intimidation display; in genera such as *Hemichromis*, a very elaborate intimidation display is followed by a serious damaging fight only if the males are well-balanced, so that neither is frightened off; finally, in *Herichthys* and some *Cichlasoma* species, the damaging fight has disappeared and a highly ritualized intimidation display is performed until complete exhaustion of one of the combatants decides the battle (Baerends and Baerends van Roon, 1950; Lorenz, 1955).

In such ritualized fights there is a specific sequence of movements which begins with (1) the broadside-on display (Fig. 8*a*), followed by (2) the erection of the vertical fins. Then follows (3) the tail beat (Fig. 8*b*) which, by means of the lateral line organ that perceives the pressure exerted, may possibly "impress" the rival with his opponent's strength. This leads to (4) the lining up of the rivals in a head-on position (Fig. 8*c*), followed by either (5) mouth-pulling (Fig. 8*d*) or mouth-pushing, depending on the species. Mouth-pulling continues until one of the fish begins to tire, becomes paler, and finally escapes.

These ritualized fights provide excellent examples of the specific sequence of a set of motor patterns. Tail-beating does not begin before the vertical fins are erected, and mouth-pulling takes place only after a few tail-beats. It is an understanding of such behavioral sequences which the ethologist seeks. An experienced observer can often predict whether a mouth-pulling battle will ensue, as well as its outcome, from the intensity of the early intimidation display and tail-beats, or whether one rival will simply flee before a serious "battle" takes place.

The simple Lorenz-Craig scheme of "appetitive behavior — releasing stimulus — consummatory act," used to describe a common behavioral sequence, sometimes proves to be a special case. An

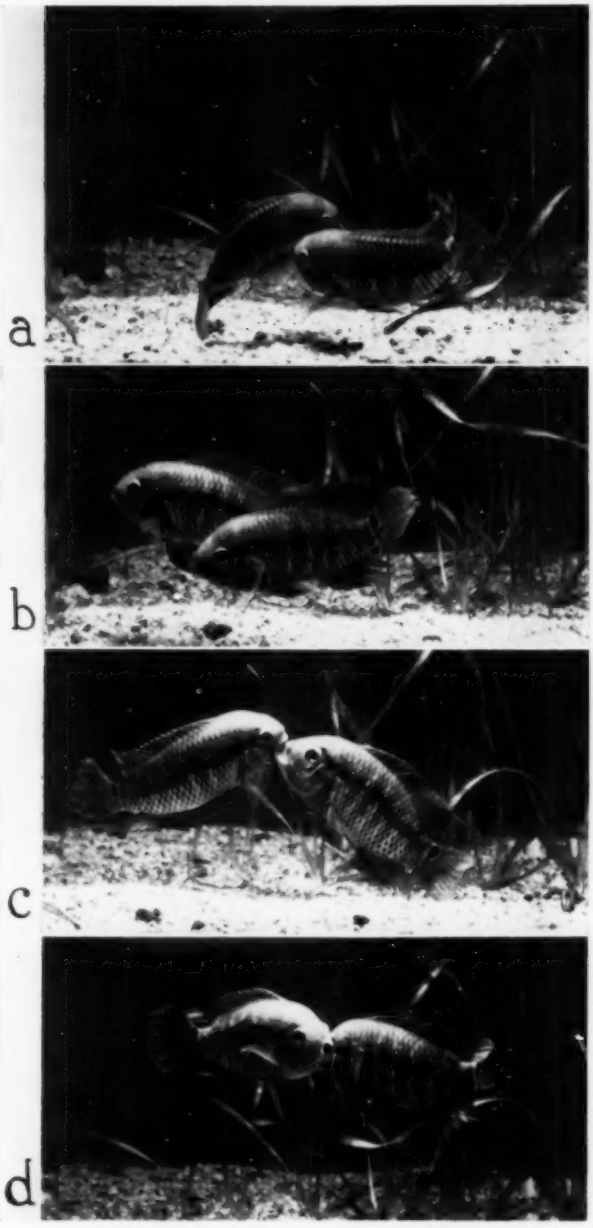

FIG. 8. RITUALIZED FIGHTING AMONG CICHLID FISH

Two males of *Aequidens* (*Acara*) *portalegrensis*. *a*, The rivals first attempt to intimidate one another by presenting their flanks to their opponent, and *b*, by each beating its tail toward the flank of the other. If they are of approximately equal strength and neither attempts to flee, *c*, they approach each other head on and, *d*, grasping each other's jaws, engage in a ritualized mouth-pulling battle until one fish tires and escapes. (Photographs: P. Leyhausen).

appetitive behavior does not always lead directly to a comsummatory act, but rather to a stimulus situation in which the next special appetitive behavior is released. The spring migration of the male stickleback is an expression of an appetitive behavior. The stimulus situation is the shallow, warm water. Here the special appetitive behavior of looking for a territory is released. Only if a suitable place is found does the further appetitive behavior of nest-building, fighting, and courting follow. As a result of such observed sequences, Baerends (1940) introduced the term "hierarchy of appetites," or as this behavior is the expression of a specific readiness to react, a "hierarchy of moods." Tinbergen (1951) interpreted these phenomena by hypothesizing a hierarchy of centers which were subordinated one to another, and which were activated one after the other. According to Tinbergen, then, an instinct is the complete hierarchical organization which responds to certain stimuli with well-coordinated behavior patterns. Such a definition, mainly based on a hypothesis, is unfortunately of little methodological value. The term "center" in Tinbergen's definition is not clearly defined, but as he referred to Hess' experiments (1948) in which various integrated behavior patterns of the cat were released by electrical stimulation of the diencephalon, it is assumed that he referred to nervous centers.

Kortlandt (1955) has shown that in some cases the fatiguing of behavior pattern *A* raises the threshold for this behavior, but does not influence behavior pattern *B*, whereas, the fatiguing of *B* on the contrary alters the threshold of behavior *A*. He concluded that in this special case there were two superordinated charging "centers," one of which feeds *A*, while the other feeds both *A* and *B*, and in his terms this represents a hierarchy of instincts.

The hierarchical organization of behavior has also been discussed by Hinde (1953, 1954). He showed that although behavior patterns in the black-tufted tit may be grouped in a hierarchical scheme, these are not clearly separated. On the contrary, some behavior patterns may be in the service of two or more instincts. Sometimes they are consummatory acts and at other times merely a means towards reaching a consummatory act. These latter have, therefore, sometimes been referred to as "appetitive acts," a term likely to be confused with the term appetitive behavior.

In young animals hierarchical organization is often incomplete and therefore seldom observed. The ontogenetic development of hierarchically organized behavior has been described for the cormorant in detail, and various theories of such behavior have been discussed by Kortlandt (1955). In the cormorant, seemingly meaningless isolated acts appear early in the behavior of the young birds, and only later become integrated into a complex functional pattern of behavior. Besides physiological maturation processes, learning may play an important role in the integration of such isolated behavior patterns, as Marx (1950) has shown in his experiments on hoarding in rats.

A disintegration of hierarchical behavior is very often observed in play, where the single acts become somehow independent of their normal superposed integration centers. During play individual acts belonging to different functions are often freely combined in a way which would normally not be possible in a real situation. Kortlandt (1955) called attention to the out-of-season disintegration, or "dis-maturation," of behavior patterns, which proceeds along exactly the same line, but in the reverse direction, as their maturation. This area of behavior deserves additional attention and investigation.

CONFLICT BEHAVIOR

Until now we have primarily dealt with behavior activated by one kind of motivation. In conflict situations, however, more than one instinct may be simultaneously activated. In such a case it often happens that two distinct fixed patterns of behavior inhibit or overlap each other, as we have mentioned in the discussion of expression movements. Many animals in aggressive mood attack intruders with a sudden jump. If fear is simultaneously aroused, however, the animal does not actually jump at the intruder, but stops suddenly before the intruder. This sudden stop is accompanied by rigid thrusts, or "braking," of the forelegs which continue to stamp on the ground, as in the squirrel, and may be accentuated by sounds and hair-fluffing. This "braking" of an aggressive behavior pattern, together with accompanying autonomic responses, may eventually become ritualized into a threat display or "Imponierbremsen" (Eibl-Eibesfeldt, 1956a).

If an activated behavior pattern is inhibited during its normal course, acts can often be observed which do not belong to the initially activated behavior. Fighting cocks, in the pauses

between actually fighting, peck on the ground in an exaggerated way without actually taking food. Many similar examples are known, and such behavior has been termed by both Kortlandt (1940) and Tinbergen (1940) "Ubersprungbewegung" (displacement activity). It has been observed in the following situations:

(a) if two drives counteract one another—i.e., aggression and flight;
(b) if a goal is attained too quickly; for example, when a fighting partner flees too soon, displacement activities may occur in the winner; and
(c) if an "anticipated" stimulus does not occur; for example, when a female suddenly stops following a leading male.

A large number of displacement activities, like the seemingly irrelevant feeding behavior which takes place between fighting cocks, have been observed in a variety of animals. Such behavior includes not only foraging movements, but body-care movements (preening, bathing, scratching, etc.), nest-building movements, sexual movements, food-begging movements, incubation behavior, and even sleep. In the three-spined stickleback (*Gasterosteus aculeatus*), sand-digging is normally motivated as a part of nest-building activity. Kortlandt (1940) referred to such behavior, motivated by its own drive, as "autochthonous" activity. Behavior which is motivated by a drive other than its own, such as the displacement sand-digging which results from the conflicting drives of aggression and flight at the margin of the stickleback's territory, he termed "allochthonous" activity. Tinbergen (1952) simply refers to these two types of behavior, in which two drives utilize a common motor pattern, as the displacement activity and the "example" from which it is derived.

It appears that displacement activities are always derived from or expressed in some form of innate motor pattern. Nevertheless, close observation indicates that there is usually some subtle difference between the displacement activity and its example. Thus, displacement sand-digging differs from true digging in that only in the former case is the ventral spine erected (Tinbergen and van Iersel, 1947). This difference (and perhaps others) enables a rival male stickleback to distinguish between these two types of behavior. Displacement digging thus acts as a kind of signal which is understood by other male sticklebacks as a threat. Displacement activities may thus acquire a social function, and gradually evolve into elaborate signaling devices or expressive movements.

Irrelevant as these displacement activities may seem when observed for the first time, thorough study demonstrates a regularity in their occurrence. Given a particular set of conditions, displacement behavior invariably occurs. Thus, much irrelevant or so-called "random" behavior is not random at all, but determined by specific outer circumstances or stimuli, and therefore lawful.

The inner circumstances or stimuli, which determine the specific motor patterns to be utilized as displacement activities under given conditions, still remain obscure. The widespread occurrence of displacement activities suggests some primary biological significance or function within the animals in which they occur, besides their secondarily acquired function as signals or social releasers. Armstrong (1950) discussed the nature and function of displacement activities in birds in some detail. Tinbergen (1952) proposed that displacements serve a function as outlets for surplus impulses which might disturb or otherwise damage the central nervous system.

Two careful analyses of the mechanism of displacement activities were recently presented at the 4th International Congress of Ethology. Sevenster (1958) undertook an analysis of displacement fanning in the 3-spined stickleback, and van Iersel and Bol (1958) carried out an investigation of displacement preening in two species of terns (*Sterna sandvichensis* and *S. hirundo*). In the latter study it was shown that displacement preening results from conflicts, either between brooding and escape, or between aggression and escape. The frequency and intensity of displacement activity were always correlated with the strength of both of two opposite, conflicting drives.

THE LEARNING HYPOTHESIS

Ethology has placed the exploration of innate behavior patterns in the foreground. In the behavior of higher animals, especially that of mammals, innate and acquired patterns of behavior are blended together into a functional unit, so that is is impossible in principle to explore one without ***knowing*** the other. Ethologists hold, however, that both elements can be analyzed by careful study, including observation of the free-living animal combined with the experimental approach.

Psychologists often agreed in principle with this formulation. Thus Watson (1924) wrote, "Fortunately in most connections psychology is not called upon to draw a sharp distinction between hereditary and acquired reactions. In making laboratory studies, however, it is sometimes necessary for us to study the details of hereditary response. We find it simpler in such cases to overemphasize for the time the definiteness of the separation. This is unquestionably a legitimate mode of procedure in science. Few biological problems permit of any other treatment."

Nevertheless, this viewpoint is the converse of the contention of some psychologists today, who claim that it is impossible to separate out learning processes from innate responses. It appears to have been a short step from not being called upon to draw a distinction between hereditary and acquired reactions, to the assumption that it cannot be done.

Let us take a concrete example quoted by Lehrman (1953), dealing with the nest-building behavior of the rat. Each adult rat, when raised in isolation, is able to build a nest. We would, therefore, conclude that innate behavioral elements are present, but according to Riess (1954), this is not the case. He raised rats, isolated at 14 and 21 days after birth, in wire cages with powdered food, so that these animals had no opportunity to handle solid objects. When he put them in the testing situation —a wooden box from the sides of which paper strips were hung—none of the animals built nests. They simply scattered the paper strips all over the cage. In the basic experimental group isolated at 21 days after birth there was no nest building, decreased retrieving of rat pups when born, and an infant mortality of 75 per cent due to the absence of suckling. No results of a control, in which rats were kept under identical conditions but permitted to handle solid food, were reported. Lehrman contends that the practice in carrying food pellets is partly equivalent, for the development of nest-building and retrieving, to practice in carrying nesting materials, and in carrying young. Taken with Kinder's (1927) demonstration that nest-building is inversely correlated with environmental temperature, Lehrman suggests that nest-building activity arises from the ordinary manipulation and collection of food (and other objects), under conditions where the accumulation of certain types of manipulated materials leads to immediate satisfaction of one of the animal's needs (warmth).

Eibl-Eibesfeldt (1955a) was able to show in this connection that the results of Riess can be traced to a methodological error in the experimental situation, and that if one avoids this error both innate and learned elements of nest-building may be readily determined. Tail-amputated rats were raised by the Riess' method, but unlike Riess' conditions, these were tested in their *home cage*. All those rats which had a fixed sleeping place (about one-third of the animals) built nests immediately. The others did so after a time of wandering about aimlessly, as the paucity of structural subdivisions in the experimental cage apparently made it difficult to choose a nesting site. In a second series of experiments a vertical tin fold was placed in one corner of the cage, separating off a small area. In such experimental cages, all isolated rats built nests behind the tin fold, before parturition, including those which had sleeping places outside the fold. Apparently the rats used in Riess' experiments failed to build nests, because they were unfamiliar with their testing cages and did not have a definite nesting site. Such a nesting site must first be fixed either by training, or by structures which release an innate orientating mechanism—otherwise, rats do not begin to pile up nesting material. The specific movements of nest building were equal in both control and experimental animals. They are certainly innate and require no handling of solid objects as a preliminary form of learning.

In the films of these experiments, which were shown at the 4th International Congress of Ethology held in Freiburg (Sept. 1957), it was evident that without prior practice or learning the nest-building rats always carried nesting material (paper) toward the nest. Not once did the mother rats fail to retrieve a newborn rat placed outside the nest by the experimenter. On the other hand, learning processes do play an important role in the utilization of various nesting materials. Whereas soft paper is readily utilized, rats must learn to handle stiff straw before they can succeed in building as good nests with the latter material alone.

No ethologist doubts that learning processes are of great importance in behavior. Lorenz (1935, 1937) has often emphasized that learned and innate elements of behavior are closely interwoven. His ravens, for example, had innate nest-building movements but had to learn which material to use for next-building. Eibl-Eibesfeldt (1957a) has recently shown that red squirrels

develop individually different techniques of nut-opening on the basis of a few innate patterns such as gnawing and a certain splitting movement. The integration of these movements into a functional unit is accomplished by learning processes in which the special form of the nut favors the development of a definite technique. Far from overlooking learning processes, as psychologically orientated criticisms of ethology imply, Thorpe (1956) has recently devoted an entire volume to the relationship of inherited and learned elements in animal behavior.

Lehrman has criticized isolation experiments on the basis that these do not take adequate account of self-stimulation by the isolated animal, such as its own chirping or licking activity, which might provide a source of differential learning. The implication here is that the results of *all* isolation experiments are questionable. Koehler (1954b) has in turn criticized Lehrman's line of reasoning in detail. Although one may consider that an animal raised in isolation is always exposed to self-stimuli from which learning may follow, there are certainly many other cases in which learning may be excluded. Sauer (1954) showed that whitethroats (*Sylvia communis*) raised in isolation in soundproof rooms develop the species-specific songs in the same sequence and at the same developmental stage as the normally raised controls. The young swift, which hurls itself out of its nest for the first time, and immediately flies to a safe landing, is as little concerned with flight learning as Spalding's swallows or Grohmann's doves. Male ducks reared in isolation show, when mature, all the highly ritualized courtship postures characteristic of the species.

A distinction between innate and learned elements of behavior does, therefore, seem prerequisite for further causal analysis. The learning psychologist who does not know what is genetically determined is in a position equivalent to a geneticist performing modification experiments on genetically unanalyzed material. Seen in this light, a knowledge of the innate behavior of animals, which ethologists have placed in the foreground, would provide the results of learning experiments with greater validity.

Tinbergen has pointed out (correspondence, 1957) that the word "innate" is not the opposite of learned, but of "environment-induced." There are many environment-induced changes which nobody would label "learning." The fact that presumptive trunk skin of a frog embryo, when transplanted into the presumptive mouth region of a newt larva, develops into a mouth, but the mouth of a *frog* tadpole, shows that the words innate or inherent, versus environment-induced, are rightly applied only to influences, not to the characters themselves. This is also true of behavior. Strictly speaking, the application of the word "innate" is a form of shorthand for the differences between species, used in the same way that the geneticist applies this word, and is not entirely applicable to the end result (or "finished product") of structure or behavior.

Schoolland (1942) was able to demonstrate that there are innate differences in the responses of ducks and chicks to water, dust, cries of distress, food, etc., even though both were incubated and reared under identical conditions. (This demonstration of innate response differences, in an experimental approach in which the environment is held constant while the hereditary factors are varied, would be an instructive laboratory exercise). In his introductory statement of the problem Schoolland indicates that since there is no way of determining when the "outer" factors begin to interact with the "inner" factors, one can arbitrarily select a point in the developmental process and study the degree to which development up to this point exerts a determining influence upon subsequent behavior. Those factors present in the organism at birth, which represent development *up to this point* and which are at the same time practical determinants of subsequent behavior he regards as *innate*, or as *representing innate constitution*. Since birth is an arbitrary point in the development process, however dramatic, it should at all times be possible to demonstrate that responses at birth are dependent upon the maturation and integration of a previous structural and functional embryonic organization. To consider such developmental processes as a form of "learning," and to use this as an argument denying the existence of innate behavioral differences, becomes an absurdity. If one were to apply such reasoning to the morphological characteristics which differentiate closely related species, one would be required to conclude, in similar fashion, that such species differences were not inherited (or innate) but were also "learned" in embryo.

Actually, it may be possible to determine when specific external and internal factors begin to react in embryonic development but such study, in view of our relative ignorance of these phenom-

ena, is at present a difficult subject. Thus in *Drosophila* local injuries of the egg effected by ultraviolet light during the first 4 hours after laying cause local defects in the resulting larva, but the imaginal characters are unaffected. If the egg is irradiated similarly 7 hours after laying localized defects are produced in the corresponding region of the adult epidermis without any visible effect during larval development (Geigy, 1931). Recently, Strean and Peer (1956) reported on the basis of a study of 228 cases of cleft palate in newborn infants that such abnormality related to a strong emotional disturbance during the critical weeks of the mother's pregnancy, when the two halves of the upper jaw normally fuse in the palatal arch. They assumed that severe emotional disturbance stimulated the adrenal gland to produce extra hydrocortisone which checks, or may actually dissolve, the formation of connective tissues between the two sides of the palate. They injected cortisone into female mice at the corresponding stage in gestation, when the palates of the embryos were forming, and produced clefts in 87 per cent of these cases. These studies demonstrate that there may be critical periods in embryological development when external factors exert a marked influence on the formation of specific structures and on behavioral responses as well. Such demonstration of external influences on the formation of embryological structures, however, would in no case be ground for asserting that the specific shape of the human palate was devoid of hereditary (innate) influence.

THE COMPARATIVE APPROACH TO BEHAVIOR

As mentioned earlier, it is the phylogenetic constancy of instinctive movements, i.e., the presence of similar, unlearned behavior patterns among related species, genera, families, and even higher taxonomic categories, which provides both the general background and focal point of ethological investigation. The ethologist observes and studies the instinctive behavior patterns of related categories of animals, much as the comparative morphologist examines related categories of animals in an endeavor to "understand" the steps in the evolution of particular morphological structures. The phylogenetic viewpoint was uppermost in Darwin's own thinking when he prefaced *The Expression of the Emotions in Man and Animals* with the following:

> As long as man and all other animals are viewed as independent creations, an effectual stop is put to our natural desire to investigate the causes of Expression. By this doctrine anything and everything can be equally well explained; and it has proved as pernicious with respect to Expression as to every other branch of natural history. With mankind some expressions such as the bristling of the hair under the influence of extreme terror, or the uncovering of the teeth under that of furious rage, can hardly be understood except on the belief that man once existed in a much lower and animal-like condition. The community of certain expressions in distinct though allied species, as in the movement of the same facial muscles during laughter by man and by various monkeys is rendered more intelligible if we believe in their descent from a common progenitor. He who admits on general grounds that the structure and habits of all animals have been gradually evolved will look at the whole subject of Expression in a new and interesting light.... When I read Sir C. Bell's great work, his view, that man had been created with certain muscles specially adapted for the expression of his feelings, struck me as unsatisfactory. It seemed probable that the habit of expressing our feelings by certain movements, though now rendered innate, had been in some manner gradually acquired. But to discover how such habits had been acquired was perplexing in no small degree. The whole subject had to be viewed under a new aspect, and each expression demanded rational explanation.

Enunciation of the theory of evolution by Darwin and Wallace resulted in the increased utilization of comparative methodology in many areas of biological investigation. It provided the stimulus for the growth of comparative morphology, comparative physiology, comparative embryology, and other disciplines, and these in turn enriched both the factual and theoretical domain of biology. Darwin himself made little distinction between the evolution of morphological structure and the evolution of instinctive behavior. In his chapter on "Instinct" in *The Origin of Species* he stated, "The canon in natural history of *Natura non facit saltum* is applicable to instincts as well as to corporeal structures." In his book *The Expression of the Emotions in Man and Animals* he clearly demonstrated that it was possible to reconstruct the history of the muscular movements, together with accompanying modifications of the respiratory pattern, involved in those aspects of behavior termed "expressions." Jennings (1907), in his studies on the behavior of the starfish, likewise

pointed out that there can be no greater mistake in physiology than to omit from consideration the history of an organism's responses in attempting to understand its present-day behavior. Yet, until recently, only isolated investigations along such lines had been undertaken.

Apart from the emphasis given such phenomena by ethological investigation today, Darwin's chapter on "Instinct," written almost a century ago, is surprisingly modern in its setting forth of the basic problem of the origin of innate behavior patterns in animals, as well as in the utilization of comparative observation and experimentation towards their analysis and clarification. From an historical viewpoint one may well ask how it happened that neither zoologists nor psychologists developed a truly comparative discipline of animal behavior, as was the case with morphology, physiology, and embryology.

Ross and Smith (1955), in discussing the current status of animal and comparative psychology, wrote: "We have not developed a discipline of comparative psychology. . . . It is our conviction that the comparative method in the study of behavior will persist and develop. If this development is not in the field of psychology it will develop in other fields."

Lorenz (1950) has already pointed out that the dispute between the vitalistic and mechanistic schools of behavior study provided a serious obstacle to analytical research. The reciprocal errors of both these schools prevented consideration, as well as any attempt at a causal explanation of innate behavior phenomena—particularly as regards considering the organism as a whole unitary system, as regards the directedness of behavior, and spontaneity. If the vitalists erred by resignedly attributing these phenomena to some unexplainable, supernatural vital force, the mechanists erred by omitting these phenomena from consideration, or claiming that they did not exist. In general, the acknowledged victory in this dispute went to the mechanists, since they succeeded in uncovering a tremendous array of facts and causal explanations for those discrete elements of the organism which they chose to consider, and this tour de force overshadowed for a time such phenomena as they chose to omit. Nevertheless, an *irrational* fear of vitalism still permeates most zoologists and psychologists, effectively screening from consideration those phenomena which were once considered the domain of the vitalist. It is rational for a scientist, whose aim is the causal explanation of natural phenomena, to reject vitalism, which postulates an unexplainable, supernatural vital force, but it is irrational for scientists, whose domain is the whole of living nature, persistently to omit from consideration certain elements of that nature. Biological and psychological science has grown to such proportions today that any scientist may choose whatever area of specialization interests him, but it is a serious scientific breach for any group of scientists to utilize this fear of vitalism to suggest that all other scientists should reject certain kinds of phenomena from consideration, or that such phenomena be only considered within the dogmatic framework of an existing discipline.

Perhaps historical study will eventually disclose both the basis and influence of the attitudes of the zoologist toward the subject of behavior, and how these attitudes have stifled the comparative study of behavior. Some of these attitudes and dogmas which have long prevailed within the field of biology are the following: (a) behavior is too complex to analyse; (b) behavior and physiological processes are two distinct aspects of the organism; (c) only physiological processes are capable of exact, causal analysis; and (d) the realm of behavior properly belongs to the field of psychology.

Thus, not only was the study of animal behavior relegated, so to speak, to psychology, but this was done with the additional implication that such study was neither objective nor completely scientific. It should be noted parenthetically that although zoologists seemed to shun behavior as a subject of serious study, this never prevented them from incorporating such valid explanations of *individual elements* of behavior as Loeb's Tropism Theory, or Pavlov's Conditioned Reflex Theory as a mechanistic explanation of *all* behavior.

Psychologists reacted to this background of attitudes by stressing learning and conditioned behavior, since experiments could be carried out in this area under what were considered objective, rigorously controlled conditions. It would not be altogether erroneous to say that the defensive reaction of psychologists, with which they rigorously pursued "objectivity," was responsible in part for the one-sided development of behavior theory which emphasized learning and conditioning almost to the exclusion of all else. It has already been shown that the validity of conclusions drawn

from learning and conditioning experiments, however carefully "controlled," when carried out without knowledge of the animal's innate behavior, is often open to considerable question. The problem of the survival value and evolution of animal behavior patterns has been almost entirely neglected in the psychological study of behavior.

In their quest for objectivity, psychologists also developed that area of investigation known as physiological psychology, which, in part, has emphasized the physiological changes in specific organ systems during emotional change. These investigations have certainly contributed much valuable knowledge. Physiological psychologists are well aware that emotional behavior, objectively examined, expresses itself in specific patterns of behavior, and that such specific behavior patterns have an historical explanation. But again the comparative study of innate behavior patterns in the Darwinian sense of studying related species, genera, families, etc., as the systematist or comparative morphologist does, was overlooked.

THE CRITICISM OF ETHOLOGICAL INVESTIGATION

A number of papers have appeared in recent years which have criticized the ethological approach to the study of behavior (Hebb, 1953; Kennedy, 1954; Lehrman, 1953). These criticisms have been of value in bringing to light the fact that psychologists, and perhaps biologists as well, apply two distinct sets of criteria to biological phenomena, depending on whether innate structure or innate behavior is under consideration. Both the geneticist and taxonomist know that morphological structures which are of taxonomic value, and hence inherited, are subject to environmental influence and change. Mayr (1942) has pointed out that all taxonomic characters which have been described as good species differences have been found subject to geographic variation whenever they have been studied from this point of view. The range of variation which inherited morphological structures exhibit under varying environmental influence is an important area of investigation. It is doubtful that any biologist would contend, as a result of such investigation, that the morphological differences of distinct species are not to be considered inherited, or innate. Nevertheless, this is what psychologists do when they erroneously quote experiments, which indicate that environmental factors influence behavior, as evidence against innate behavior patterns.

It should also be mentioned that to observe the fullest possible repertoire of innate movements of animals in captivity, they must be kept at a peak of good nourishment, health, and vitality. It is well known to animal fanciers and zoo curators that a reduction in an animal's vitality often results not only in the decreased beauty of its scales, feathers, or coat, but also in the diminished number or intensity of instinctive movements which it will display. Even among invertebrates, Crane (1948) found that the displays of salticid spiders must be studied when the animals are at their physiological peak, otherwise the behavior is not typical of the species. Thus it is possible, as a result of altering the environment, to so interfere with an organism's normal development that certain structures or behavior patterns do not appear at all. This is all that the experiments of many psychologists do, when they try to demonstrate that innate behavior patterns are non-existent, as Lorenz (1956) has already pointed out.

In referring to innate behavior, ethologists do not imply that they consider it unnecessary to investigate the ontogeny of such behavior, as Lehrman (1953) claims. On the contrary, one might suppose, the demonstration that instinctive behavior patterns are not the result of learning (although they may later be combined with learned behavior) would lead investigators to focus their attention on those very developmental processes and genetic influences upon which they depend. Lehrman has also suggested that preformationistic assumptions underlie the concept that some behavior patterns are inherited. Not at all. The geneticist, in shorthand fashion, refers to many inherited morphological structures just as the ethologist refers to innate behavior patterns. Neither doubts that the final structure or behavior is the result of an interaction between genetic influence, developmental processes, and the environment.

Hooker (1952), who provided an admirable survey of the origins of prenatal behavior throughout the vertebrates, pointed out that structure and function are directly and inseparably related in any living organism. An embryo develops morphologically in an orderly sequential manner characteristic of the species, and given an appropriate environment an organism's behavior likewise develops in an orderly sequential manner

which is also characteristic of the species. The morphological development of all vertebrates follows a fundamentally similar sequence and one might therefore expect the developmental sequence of behavior in different vertebrates to possess certain fundamental similarities, but to differ in particulars in different species. This is precisely what Hooker concluded when, as a result of a survey and studies of vertebrate embryonic behavior, he wrote: "It is evident that each class of vertebrates, perhaps each order, genus and species, exhibit characteristics in the development of behavior which belong to that subdivision of animals alone." This suggests that the developmental sequence of embryonic behavior is part of an inherited pattern, rather than a learning process.

As has been pointed out, the environment, which at all times exerts an influence on the sexual state and the vitality of animals, often determines whether or not a given innate pattern of behavior will be displayed at all. It is the *form* of the behavioral movements, once aroused, which is inherited or constant. Ethologists use as criteria of *fixed behavior patterns* that 1) the behavior be constant in form; 2) it be characteristic of the species; 3) it appear in animals which have been raised in isolation from others; and 4) it develop in animals which have been prevented from practicing it. These criteria, however, should not be so narrowly interpreted as to exclude other pertinent biological considerations. Every geneticist would expect to find inherited differences in structure *within* species. There is no reason why fixed behavior patterns could not possess, within species, the same inherited variability that one finds in morphologically inherited traits.

Lehrman is right in pointing out that the term "innate" when applied to a behavior pattern still leaves many questions to be answered. Some of these are the following.

(1) What mechanism would best explain the observed lawfulness associated with fixed patterns of behavior?

(2) How does the animal achieve the coordination and proper succession of the specific movements, underlying innate behavior patterns, at a particular time in ontogenetic development?

(3) How does the performance of certain behavior not only regulate subsequent behavior, but metabolic activity as well?

(4) How are inherited patterns of behavior transmitted to offspring?

No student of ethology is unaware of the questions which comparative animal behavior raises. Whereas these questions have been largely overlooked by both the psychologist and the general biologist, ethologists have, over the past two decades, actively attempted to answer them.

Critical papers, such as those of Hebb (1953), emphasize the fact that learned and innate elements are closely linked together in all functional behavior, and that we cannot dichotomize mammalian behavior into learned and unlearned, environmentally determined and hereditarily determined. Such papers imply that ethologists are unaware of this relationship, but as has been shown, no ethologist would deny the importance of environmental influences on behavior. Ethologists believe, conversely to Professor Hebb, that such a functional unit is capable of analysis just as any other natural function, regardless of the difficulties, and the previous review indicates how this has been done.

The parallel between certain ideas in ethology and psychoanalysis led Kennedy (1953) to question the objectivity of ethology, as well as to brand it a dualistic and hence a vitalistic approach to animal behavior. Kennedy, who acknowledges that subjective phenomena play some *causal* role in behavior (which the ethologist does not), feels that in science the linking of subjectivism to phenomena, concepts, or theories, is a sufficient deterrent to their serious consideration. Thorpe (1954), in answering this criticism of ethological objectivity, has pointed out that *all* concepts are ultimately subjective in origin. It is usually possible to restate them with whatever degree of respectability may be required by the climate of scientific opinion at the moment.

It should be mentioned that ethological investigation has developed independently of psychoanalytic theory. In fact, Kortlandt (1955) has criticized ethologists for having ignored psychoanalytic theories of instinct in their investigations. Nevertheless, Kennedy's criticism deserves more attention, for it has the merit of openly stating what is often tacitly implied in other criticisms.

Classical biology and academic psychology have largely ignored or rejected those clinical findings and theory which Freud (1938) developed at the turn of the century towards the understanding of various forms of disturbed human behavior. In

particular, the lawfulness with which certain events in the ontogeny of human beings led to obsessional, neurotic, hysterical, and psychotic forms of behavior, and the regularity with which such behavior was associated with disturbances in sexual function became apparent. His findings represented an important milestone in scientific observation and methodology, notwithstanding the fact that biologists and psychologists preferred to view his work as so much "unscientific psychology." In this viewpoint they overlooked the fact that Freud had already demonstrated proven research capacities as a general biologist, histologist, and neurologist (Jones, 1953). As a result, biologists failed to ask a significant question, which Freud's clinical findings certainly demanded —namely, if specific events in the early years of infancy result in neurotic behavior and such behavior is associated with sexual disturbances, what is the physiological mechanism through which this is accomplished?

The social fear of the essentially biological problem of sexuality has effectively hampered fruitful inquiry in this area, much as the fear of vitalism provided a serious obstacle for analytical research in the realm of animal behavior generally. As a consequence, it was not the biologists, but that specialized group of psychoanalytically oriented physiologists who developed the field of psychosomatic medicine and provided insight into the regularity with which various metabolic diseases appeared in specific personality types. It is to the work of this discipline that we owe much of our knowledge of the role of the autonomic nervous system in such diseases.

The viewpoint that psychoanalytic findings and theory, which deal with an underlying lawfulness in human behavior, is merely unscientific psychology, has crystallized into an acceptable illusion among many biologists and psychologists. It is not at all unlikely that the independent demonstration by ethologists of lawful behavior in animals threatens to shatter it. If biologists persist in this attitude they will almost certainly overlook another central biological problem dealing with certain mechanisms involved in evolution. Morris (1956) has shown that the feather postures of birds, primarily concerned with temperature regulation and under the control of the autonomic nervous system, may, under thwarting stimulus conditions, take part in secondary responses. It appears that these secondary responses, under the pressure of selectivity, may ultimately become ritualized and evolve into special signals. There is considerable evidence that similar secondary autonomic functions are involved in the evolution of signals among other animals.

It is beyond the scope of this paper to provide a full comparison of ideas in psychoanalysis and ethology. It is only our intention to show that the attitude which accepts lawful phenomena in the realms of physics and chemistry, but assumes that there are no laws in the biological realm of behavior, has seriously curtailed investigation in the past. It should be mentioned, however, that Kortlandt (1955) has presented a detailed discussion of the concept of instinct and its relation to hierarchy theory, as developed both in psychoanalysis and by students of animal behavior. Barnett (1955) has discussed possible relationships between displacement behavior in animals, and both psychoneurotic behavior and psychosomatic disorders in man. In a discussion of the nature and function of displacement activities, Armstrong (1950) likewise called attention to their similarity in man and animals.

Kennedy's second criticism of ethology is that it is dualistic *and hence vitalistic*. The approach of vitalism towards life phenomena was dualistic, but the corollary that all dualism is vitalism by no means follows. The rejection of vitalism from the realm of scientific consideration is not based on its dualistic nature, but rather on its postulation of an unknowable, supernatural agency. A dualistic approach is often a necessity based upon ignorance of connecting links or basic laws. Thus, the separation of the study of matter into the realms of physics and chemistry—the one based on the demonstration of distinct physical laws, the other on chemical interaction and forces—was certainly dualistic. It required the work of many generations of scientists before the quantum theory of Max Planck was able to provide an underlying unifying principle. Moreover, it was the dualistic approach to the study of matter which permitted the gradual technological and factual accumulation of knowledge in both these fields and thereby made the demonstration of a unifying concept possible. That accomplishment might still be denied us today if physical science had been able to dictate to the young, still-suspect science of chemistry the nature of its experiments, methods, and thinking.

[Notwithstanding the unifying concept embodied in quantum physics, some physicists still regard it as a dualistic theory. Thus Einstein and Infeld (1947)

write: "The new quantum physics removes us still further from the old mechanical views, and a retreat to the former positions seems, more than ever, unlikely. But there is also no doubt that quantum physics must still be based on the two concepts: matter and field. It is in this sense a dualistic theory and does not bring our old problem of reducing everything to the field concept even one step nearer realization."]

Criticisms of individual ethological experiments, observations, and thinking are to be welcomed. The recent criticisms of ethology as a scientific discipline, however, have indicated that biologists and psychologists frequently start with assumptions concerning behavior which are contradicted by fact.

SUMMARY

In summary, it may be said that ethology does not have a complete theory, but rather has contributed a considerable number of verifiable facts which do not wholly fit within existing physiological or psychological explanations of animal behavior. These are as follows:

1. Certain patterns of behavior, termed instinctive movements, possess taxonomic value among diverse groups of animals, i.e., they often show the same species specificity as shown by morphological structures.

2. These fixed patterns of behavior, like structures, may be studied and, in part, "understood" from the viewpoint of phyletic descent. They have evolved from homologous, ancestral behavior.

3. There exists an hitherto unexplained lawfulness governing behavior which is expressed through instinctive movements, leading to such associated phenomena as displacement activities, intention movements, ambivalent responses, regressive behavior, and an inherited sequence of movements.

Ethological investigation has focused attention not only upon the general problem of the physiological mechanisms underlying behavior, but upon the specific problem of how the various physiological mechanisms, fixed patterns of behavior, and specialized structures have become integrated into a unified system in the course of their evolution. Hand in hand with the systematic work of uncovering the distribution of such phenomena in the animal kingdom, and in addition to conducting many remarkable experiments, ethologists have made and unmade hypotheses. This is part of the growth of all scientific disciplines. As a first truly comparative approach to the behavior of animals, ethology should be of interest to many other fields of study. It is hoped that studenst of biology, physiology, psychology, and related disciplines will first verify the facts concerning animal behavior, and then ultimately contribute to their explanation.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

SOVIET EDUCATION FOR SCIENCE AND TECHNOLOGY. *By Alexander G. Korol. The Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, New York.* $8.50. xxv + 513 pp. 1957.

When the sputniks were put into orbit some months ahead of our own satellites, we experienced one of our rare occasions of self-evaluation. We had known for some time that the Russians were graduating three times as many engineers as we were and, suddenly, we wanted to know why. Something seemed to be wrong with our educational system, our complacency in regard to our schools was suspended temporarily, and we began to compare our public schools with those of the Russians.

A generation ago we had abandoned our public schools to the educationists and, when we discovered what they had done to them, we were properly horrified. By comparison, the Soviet schools seemed to be effective and worthy of emulation. Our professional educators, however, rallied quickly to their own defense and declared that we did not want to—and should not—make our schools like those of the Russians. As far as the professors of education were concerned, our schools were doing a good job. Incidentally, they seemed to be convinced that there were but two kinds of schools—the American and the Russian—and we would have to have either the one or the other. The defects of our public schools, however, could be concealed no longer, and fundamental changes in our educational standards were indicated; but the discussion shed no light at all on the schools and academic standards in the Soviet Union. We merely assumed from the success of the sputniks that the Soviet schools must be excellent, but our ignorance of Soviet educational practices was almost complete.

This ignorance need not persist. Alexander Korol's *Soviet Education for Science and Technology* is sufficient in itself to dispel any misconceptions we might have. The book is detailed, factual, and thoroughly documented. It describes Soviet education from the first grade of the primary school to the most advanced postgraduate research in the universities. It traces the history of the Russian schools from the revolution of 1917 to the latest directive of the Communist Party. It describes the efforts made to educate the masses

and the standards of selecting from the masses those who are worth educating further. It lists the curricula of the various schools, the hours devoted to the various subjects, and it even prints some of the examination questions to show how well the pupils learn. The whole treatment is explicit and factual but the author is never lost in the details.

It is impossible to describe the Soviet educational system and standards in a few words, or to trace its history in a review of reasonable length. One or two of its characteristics, however, may be cited. Immediately after the revolution and during the period of doctrinaire Bolshevism, the Russians seem to have made every possible mistake, including many of the errors that we ourselves have made. Fortunately for the Russians, however, their errors were so egregious and the immediate results so catastrophic that they were forced to correct the mistakes and face their problems realistically. Now they seem to have gotten a great many of their mistakes out of their system. They can now get down to the serious business of training the young in accordance with their objectives.

It may be useful to us to learn a little of what the Soviet schools went through. The following instances are samples.

In 1918, the Russians went in for progressive education in a big way. "The teaching plan . . . emphasized group activities; textbooks were all but abolished; and there was no compulsory homework of any kind. All examinations . . . were abolished; the schools were forbidden to take any disciplinary action against students; the internal management of each school was entrusted to the school council, which included one student representing each age group of pupils 13 years and older. . . . All accounts agree that the result . . . was educational chaos."

In the early years of the Revolution the standards of admission to the universities were also most democratic. According to a decree of 1918: "Any person irrespective of citizenship or sex who has reached the age of sixteen may enroll as a student at any institution of higher learning without having to submit a diploma, certificate or any other evidence of completion of secondary or other schooling."

This decree specifically prohibited the school authorities from requesting any other information except the age and identity of the applicants, and thus went farther than our own state laws that now limit the information that our colleges and universities may obtain from their prospective students.

These early standards represent the nadir of Soviet education. During the last thirty years the improvement has been spectacular. Doctrinaire equalitarianism has been discarded. Students in Russian schools are made to work, and in some schools they also have to work at other tasks. Granting the validity of the Soviet objectives the education is remarkably successful. "Soviet education reflects two dominant objectives: first, to inculcate a complete—and, if possible, devout and enthusiastic—commitment to the will and the ways of the Communist Party; and, second, to develop maximum technical competence for work in designated occupations and capacities." This is not our concept of education, of course, but it is one we shall have to reckon with.

No short review can cover all of the important categories of information that Korol has asembled, and but one other aspect of Soviet education will be noted. It is rigid, dogmatic, and controlled firmly by the highest autocratic authorities. If the education of the whole world was controlled in this way, we can be certain that the future progress of our species would be delayed indefinitely. But in its short-term effects, Soviet education meets its objectives very efficiently, it strengthens the Soviet Union, and it gives the Soviet student a mass of information that our own students find impossible to obtain without working and studying. It contains much propaganda, some misinformation and, except in certain technical subjects, no freedom. Its short-term efficiency, however, presents us with a challenge that we will have to meet.

CONWAY ZIRKLE

SCIENCE IN AUSTRALIAN PRIMARY SCHOOLS.

Edited by C. D. Hardie. Cambridge University Press, London and New York. $3.75. vii + 90 pp. + 1 folding chart. 1957.

This volume contains 9 chapters written by 5 members of faculties of various Australian University Schools of Education, as well as a chart showing science curricula in 5 Australian states.

The subjects discussed are: the meaning of science and its place in education; aims and expected results of science teaching in the primary school; science curricula in Australian primary schools; a suggested syllabus for primary school science; some principles of learning and elementary science; apparatus and aids in the teaching of elementary science; teacher training for primary school science; educational measurements by means of scientifically constructed tests; and topics for discussion and for future investigation.

Judging from the book, the conditions existing in Australia in regard to teaching science in the lower grades are similar to those existing in the United States. Apparently there is a feeling among educators that both the theory and practice of science teaching in the primary schools have been seriously neglected. There seems to be no formulated list of objectives which is generally accepted. No properly equipped science rooms have been provided for primary schools. The existing syllabi are too heavily weighted toward nature study and biological science in general. Time allotment

for science instruction is insufficient to cover the work outlined in the syllabi. Primary teachers do not have sufficient education to be competent to teach science. According to the book, the present minimum qualifications for entry into the teaching profession have not always been adhered to during periods of teacher shortage.

Several recommendations for the improvement of science teaching are offered. These include a suggested syllabus for children 5 to 11 years of age, under the following headings: the human body; the care of the body; other living things; everyday things; and conservation. These topics are developed in certain sequence through the 6 years. A list of necessary materials and equipment, as well as specifications for a proper science room, a combination of museum, workshop, and laboratory, are given. Special courses in science during teacher training, suitable for preparing primary teachers, are suggested.

Several of the contributors refer to American publications on the subject of teaching elementary science. These are appraised in terms of their soundness and applicability to the Australian situation.

MARY DEMEREC

QUESTIONS AND PROBLEMS IN SCIENCE. *Test Item Folio No. 1.*

By Paul L. Dressel and Clarence H. Nelson. Cooperative Test Division, Educational Testing Service, Princeton and Los Angeles. $27.50. xvi + 805 pp.; ill. 1956.

The best science classroom examinations are of local construction, composed to fit precisely particular courses with their special emphases. These examinations not only give a valid evaluation of factual retention, *per se*, but also reveal the ability to integrate and to "think on one's own." They point clearly to areas of weakness and may, on occasion, even lead the student to new lines of emphasis or thought. Composing an adequate examination requires considerable time, ingenuity, study, and experience. This is a combination not often achieved. All too frequently, inferior examinations are prepared or "repeat performances" are staged. The great and often necessary emphasis on test grades in most colleges and universities demands a fuller and a fairer evaluation of the student than he is given in many instances.

Dressel and Nelson have compiled close to 6,500 sample, short-answer test questions, arranged into 31 convenient content categories of the biological sciences. An approximately equal number of questions on the physical sciences is also included. Questions of both a general and a specific nature are included under a wide spectrum of topics, such as: photosynthesis, excretion, characteristics of living organisms, heredity, classification, etc. Each question has a somewhat arbitrary designation as to its objective (viz., knowledge, comprehension, application, analysis, synthesis, and evaluation). Subdesignations are even included for those who are worried about whether a question tests the ability, for example, to analyze "elements," "relationships," or "organizational principles"! Nevertheless, the volume contains a vast selection of questions, most of which are of good quality and quite amenable to usage, either directly or after only very slight modification. Most topics which one encounters in a college course in general biology are represented. It would seem that even the extreme individualist will find here at least a few very good suggestive ideas to aid him in the development of his own objective examinations.

PHILIP E. HARTMAN

THE TAO OF SCIENCE. *An Essay on Western Knowledge and Eastern Wisdom.*

By R. G. H. Siu; decorations by Veronica Rusicka. The Massachusetts Institute of Technology, Cambridge, and John Wiley & Sons, New York; Chapman and Hall, London. $4.25. xvi + 180 pp.; ill. 1958.

R. G. H. Siu, in his essay on Western knowledge and Eastern wisdom, has chosen to analyze "against the reflective tradition of the orient," as he puts it, the management of organized Western research. The contrast between the passions for action in the West and the satisfactions of contemplation in the East is a sharp one, and the author has written a book of great interest in pointing out what the West might learn from the East in tempering some of its practices.

It is regrettable that the author spends so many more pages on the exposition of his views on the history and organization of Western science than he devotes to descriptions and explanations of Tao itself—but perhaps this is the way of Tao. It is also disappointing that he selected the organization of research, rather than science as a mode of creative thought, as the main subject of what he calls his case study. One may hope for other volumes from his very fluent pen with these other emphases, but meanwhile the present one is strongly recommended to readers who desire insight into perceptive Eastern thoughts on familiar Western actions.

JANE OPPENHEIMER

RELIGION WITHOUT REVELATION.

By Julian Huxley. Harper & Brothers, New York. $4.00. x + 252 pp. 1957.

This book first appeared, according to its Preface, in

the 1920's, and, after having gone out of print, was republished in a much abridged form in 1941. Since the present edition has undergone much alteration, and includes 2 (out of a total of 9) completely new chapters, it will be reviewed in its own right, rather than merely noticed as a new edition.

Sir Julian has been troubled, for himself and for man, by the growing difficulties in attempting to reconcile religious ideas, in particular those depending on belief in a personal deity, with the knowledge of the universe now accumulated by science. "The supernatural is being swept out of the universe in the flood of new knowledge of what is natural," he writes. And elsewhere, "If events are due to natural causes they are not due to supernatural causes."

These essays attempt to explain his conviction that religion "of the highest and fullest character" can coexist with a complete absence of belief in the supernatural. Faith itself he views as a phenomenon of the mind. Through considerations of historical, comparative, psychological, and philosophical aspects of religion, he develops his defense for what he calls evolutionary humanism as a religion for today. He conceives of this as a belief-system which, although it has grown beyond the need for personal gods, operates by adjusting man to his destiny, and by enabling the individual, through fulfillment of his capacities, to maintain and improve the continuing social process and the march of evolution as a whole.

He avoids, rather narrowly, the pitfall of equating science with religion, partly on the basis that a sense of the sacred is one of the keys to religious significance: "The essence of religion springs from man's capacity for awe and reverence." Aesthetic appreciation, science, and religion all are expressions of piety; feeling, action, and belief are all components of it. This is no cold doctrine, and the role of immediate personal involvement is never for a moment forgotten. The book is anti-skeptical, and grows out of conviction that there is a necessity to believe.

There is much in the argument with which many may disagree. Not every theologian will concur that "gods are among the empirical facts of cultural history. Like other empirical facts, they can be investigated by the method of science—dispassionate observation and analysis, leading to the formation of hypotheses which can then be tested by further observation and analysis, followed by synthesis, and the framing of broad interpretive concepts. . . . They are theoretical constructions of the human mind, in the same way as are scientific theories and concepts: and, like scientific theories and laws, they are based on experience and observable facts." Neither will every philosopher agree that "the only Absolute that man can know is the absolute of general idea—truth, beauty, goodness, holiness, unity. . . . There is an absolute of truth; and though no one can grasp all truth or, what comes to the same thing, all the implications of a single truth, yet we may solve the particular problem we have before us, we may see in a flash our solution, its truth, and its relation to many of our other ideas." Not even every biologist may accept his statement that "biology has revealed man's place in nature. He is the highest form of life produced by the evolutionary process on this planet, the latest dominant type, and the only organism capable of further major advance or progress." Huxley defends the concept of highness: "It is . . . perfectly proper to use terms like *higher* and *lower* to describe different types of organism, and progress for certain types of trend. A higher organism is one which has realized more of the inherent possibilities of living substance, and biological progress denotes those trends which do not restrict the further realization of those possibilities." Does he remember Darwin's quotation of a fragment first translated into English by Thomas Henry Huxley? "To attempt to compare," wrote Darwin in the *Origin of Species*, "in the scale of highness members of distinct types seems hopeless; who will decide whether a cuttle-fish be higher than a bee—that insect which the great von Baer believed to be 'in fact more highly organized than a fish, although upon another type?' "

Students of religion may wonder, furthermore, how perceptively Huxley measures the attempts which many organized religions themselves are making to meet his own problem. In one of the rubrics to his chapter on comparative religion, Sir Julian quotes Parson Thwackum in Fielding's *Tom Jones* as saying, "When I mention religion, I mean the Christian religion; and not only the Christian religion, but the Protestant religion; and not only the Protestant religion, but the Church of England." It can hardly be that Sir Julian set out to imitate him, but the fact is that he exhibits some of the same tendencies as the Parson. He reveals these not only in his overt and rather brave criticisms of some non-Protestant Christian doctrines, but also in a number of other unconscious admissions. "When we first travel abroad," he writes, "the chief feelings are almost invariably those of amusement and disdain, not infrequently mixed with unreasoning hostility, towards human beings who conduct the business of life in ways so different from those to which we are accustomed." This is not the former Director-General of UNESCO who speaks; it is a rather provincial Englishman, of recognizable type. When he refers several times to the gospel of work, and to work as salvation, he betrays his preoccupation with specifically Christian doctrine. While he alludes occasionally to Buddhism, he barely mentions Islam and Judaism and has not listed the two latter religions in the index.

The argument is dense and sometimes tortuous, and the writing occasionally self-conscious; the book is not always easy to read. It deserves, nonetheless, a wide reception. Whether the reader agrees or dis-

agrees with the author, he will be stimulated to think deep into a problem that tortures our time, as ethics decline with the diminution of the old formal religious respects and fears. And it is hard to see how any reader, no matter what his creed or lack of it, can fail to admire and respect Sir Julian for his forthrightness, courage, and integrity in expressing his opinions. His grandfather, a little over 75 years ago, once wrote him a charming letter about water babies: "There are some people who see a great deal and some who see very little in the same things. When you grow up I dare say you will be one of the great-deal seers and see things more wonderful than Water Babies where other folks can see nothing." Sir Julian has fulfilled the prophecy; all honor to him, not only for his vision into the wonders of nature, but also for his altruism and his complete and utter honesty.

JANE OPPENHEIMER

RELIGION, PHILOSOPHY, AND SCIENCE. *An Introduction to Logical Positivism.*

By Burnham P. Beckwith. Philosophical Library, New York. $3.75. 241 pp. 1957.

In this book Beckwith attempts to present the principles of logical positivism to the layman. In addition to presenting the tenets of what he calls orthodox logical positivism, he also makes, in his own words, "some significant contributions. Among these are: (1) the claim that a whole theory of semantics can be derived from the principle of verifiability, (2) the theory that logical positivism is based on semantic rather than logical analysis, (3) a partial synthesis of Comtean and logical positivism, reflected in our title and in the outline of this book, (4) a detailed application of logical positivist theory to religion, (5) the argument that logical positivism is not a philosophy, and (6) the criticism of scientific terms like *law, force, matter, and attraction*" (pp. 10–11).

There are 5-chapters in the volume. The first, the introduction, defines and discusses positivism and semantic analysis. The next 4 chapters are devoted in turn to religion, philosophy, science, and personal conduct.

"The nouns most often used meaninglessly by biologists," writes Beckwith in terms of his own meaning of meaninglessness, "include *life, vitality, soul, vital force, entelechy, structure, form, heredity, vital power, evolutionary purpose, instinct, drive, and trait.* Partly because of the use of such nouns, biologists have wasted a great deal of money trying to answer meaningless questions concerning the nature of life, death, and vitality, the purpose of evolution, the location of the soul or vital force, etc." (p. 168). It is my own belief that the statement could be verified that not many readers of the *Quarterly Review of Biology* are spending either much time or money investigating questions concerning the nature of life, death, and vitality, the purpose of evolution, or the location of the soul or vital force, and I predict that this book will not be much to their taste.

JANE OPPENHEIMER

FOR FUTURE DOCTORS.

By Alan Gregg. University of Chicago Press. $3.50. ix + 165 pp. 1957.

Alan Gregg during his lifetime enjoyed wide acclaim for his sagacity and imagination. Although in an entirely different fashion than either, he probably exerted as much influence on medical education as did William Osler and Abraham Flexner before him. Like Flexner, he made it his business to concern himself with medical institutions; but like Osler he never for a moment overlooked the paramount importance of the individual physician in medical practice. In this volume, which republishes 11 of his essays and talks, Alan Gregg speaks to the individual even when he addresses the institution.

Gregg wrote with simplicity, with wit and perception. While the chapters are varied in intent, a number of themes recur in them: the uses of language and narrative and history; the virtues of self-criticism; and perhaps most pervasive, the values of recognizing that "being a good student is not as interesting as forever becoming one more completely."

The book is addressed, by its title, to young potential physicians, but it will be welcomed also by all physicians and educators, and indeed by all men of compassion and humility.

JANE OPPENHEIMER

SCIENCE AND HUMAN VALUES.

By J. Bronowski. Julian Messner, New York. $3.00. 94 pp.; ill. 1958.

THE ATOMIC AGE AND OUR BIOLOGICAL FUTURE. *By H. V. Brøndsted; translated by E. M. Huggard. Philosophical Library, New York.* $2.75. xiv + 80 pp. 1957.

BIOLOGY: HISTORY AND BIOGRAPHY

A SHORT HISTORY OF ANATOMY AND PHYSIOLOGY FROM THE GREEKS TO HARVEY.

By Charles Singer. Dover Publications, New York. $1.75 (paper). xviii + 209 pp.; ill. 1958.

Under this title the publishers have made available Singer's book, *The Evolution of Anatomy* (1925), which

has been out of print for a number of years. The present edition is essentially similar to the original one and includes only a very few minor revisions. Singer has not attempted in it to take cognizance of the work which has been published during the last quarter of a century; for instance, Fleming's important reinterpretation of Galen's concepts of the movement of the blood is ignored. Nonetheless, this book remains of great value because of its feeling for the development of the spirit of anatomy and physiology, and Dover has performed a service to both students and teachers by putting it once more into print.

JANE OPPENHEIMER

JOHN AND WILLIAM BARTRAM'S AMERICA. *Selections from the Writings of the Philadelphia Naturalists. American Naturalists Series.*

Edited by Helen Gere Cruickshank; foreword by B. Bartram Cadbury; illustrated by Francis Lee Jacques. The Devin-Adair Co., New York. $5.00. xxii + 418 pp. + 9 pl.; text ill. 1957.

This, the fourth volume in the American Naturalists Series, is a selection of the writings of John and William Bartram, who, father and son, were the foremost naturalists of 18th century America. William's book, *Travels through North and South Carolina etc.*, ranks close to Gilbert White's *Natural History of Selborne.* There is no way, in a short review, to capture the drama, romance, and love of nature which is mirrored in the accounts gathered together in this volume. One must read it for himself—and is heartily urged to do so. True, some of the interpretations of things observed are erroneous, but one should not expect otherwise considering the time and circumstances. This is a wonderful account of the natural history of colonial America. The black-and-white illustrations of Francis Lee Jacques are superb and fit the text beautifully.

V. G. DETHIER

BIOGRAPHICAL MEMOIRS OF FELLOWS OF THE ROYAL SOCIETY. *Volume 3.*

The Royal Society, London. 30s. vi + 328 pp. + 21 pl. 1957.

This is the third volume in the new series continuing the *Obituary Notices* which were published until 1954. Twenty-one memoirs, each with portrait and bibliography, comprise this handsome book.

Of special interest to biologists are the following: Alexander, Earl of Athlone—(1874–1957), a member of the British Royal Family, and a great public administrator who did much for the advancement of medical education and research; Frederick George Donnan (1870–1956), a physical chemist whose theory of membrane equilibrium is known to several generations of physiologists as the "Donnan equilibrium"; Arthur Felix (1887–1956), microbiologist and immunologist; Percival Hartley (1881–1957), biochemist and immunologist; Albert Jan Kluyver (1888–1956), general microbiologist; Henry Nicholas Ridley (1855–1956), botanist; William Wright Smith (1875–1956), botanist; Leonard Frank Spath (1882–1957), paleontologist; Arthur George Tansley (1871–1955), botanist; Oscar Werner Tiegs (1897–1956), entomologist (morphology and physiology); Hubert Maitland Turnbull (1875–1955), pathologist; John William Trevan (1887–1956), pharmacologist.

Nine memoirs are dedicated to: 2 astronomers (John Evershed, Henry Norris Russell); 3 physicists (Louis Vessot King; Harold Roper Robinson; John Sealy Townsend); a geologist (Norman Levi Bowen); a geodesist and surveyor (Gerald Ponsonby Lenox-Conyngham); a chemist (Frederick Soddy); and a mathematician (Herman Weyl).

MORRIS C. LEIKIND

REASON AND CHANCE IN SCIENTIFIC DISCOVERY. *By R. Taton; translated by A. J. Pomerans. Philosophical Library, New York.* $10.00. 171 pp. + 32 pl. 1957.

Reviewed in the original French edition, *Q.R.B.*, 31: 288 (1956). A work of the greatest interest to all concerned with the history of science and the nature of scientific discovery.

THE PRESERVATION OF YOUTH. *Essays on Health. By Moses ben Maimon (Maimonides); translated from the Original Arabic; introduction by Hirsch L. Gordon. Philosophical Library, New York.* $2.75. 92 pp. 1958.

THE CRACHERODE SHELL COLLECTION. *Bull. Brit. Mus. (nat. Hist.), Hist. Ser., Vol. 1, No. 4.*

By Guy L. Wilkins. The British Museum (Natural History), London. 21s. (*paper*). Pp. 121–184 + 6 pl. 1957.

DR. ALBERT WANDER—GEDENKVORLESUNG. *Heft 1. By Alexander von Muralt, Howard W. Florey, and Jacques Tréfouël. Hans Huber, Bern and Stuttgart; [Intercontinental Medical Book Corporation, New York].* DM 12.40 (paper). 89 pp. + 8 pl. 1958.

THE YOUNG NATURALIST

SUN, EARTH, AND MAN.

By George P. and Eunice S. Bischof; drawings by Jere Donovan. Harcourt, Brace, and Co., New York. $2.75. 118 pp.; ill. 1957.

The book presents briefly the history of the earth from the time of its formation to the present. It begins with a brief description of the planets, the sun, and the structure of the universe. In the 6 sections that follow, the authors tell the latest theory of the origin of the earth, the beginning of life on this planet, the migrations of early men, the settling of the earth, the adaptations of human beings to their environment, and their attempts to control it. The last 3 sections deal with modern problems of the wasteful use of natural resources, latest projects in conservation, and new frontiers of science.

The material included is well selected, and answers questions which are frequently asked by children: how was the earth made? is there life on Mars? why did the dinosaurs disappear? how can solar energy be used? The authors are careful to point out that many of these answers are based on theory and not on fact.

The book is very well suited for use as an introduction to the various fields of science, or by a teacher to stimulate children's interest in these fields. It is sure to trigger further delving into the many topics covered in the book.

MARY DEMEREC

FINDING FOSSIL MAN.

By Robin Place. Philosophical Library, New York. $7.50. 126 pp. + 31 pl.; text ill. 1957.

According to the dust jacket, this book is primarily intended for use in secondary schools and evening classes. It will probably appeal to the average teenager, but scarcely to the intelligent adult layman, for the authoress, possibly in an attempt to avoid complexity, frequently lapses into a condescending, almost juvenile tone. The result is an elementary and often annoyingly inadequate account of what is known about human evolution. The point of view, moreover, is archaic, being downright Lamarckian; perhaps because the authoress is an archeologist rather than a biologist. One cannot help but wonder why the last chapter, The Creation of Man, was included. Undoubtedly the best part of this book resides in the many, excellent photographs.

BUILDING HEALTH. *Second Edition.*

By Dorothea M. Williams; drawings from the studio of Waneeta Stevic, University of Colorado School of Medicine. J. B. Lippincott Company, Chicago, Philadelphia, and New York. $3.60. xii + 431 pp.; ill. 1956.

Building Health is a textbook designed for the junior high school student's instruction in health education. It is based on the same Denver study and follows a format similar to that of *Enjoying Health*, which was written for senior high school students. The first two chapters contain introductory material that includes an argument for the need and importance of the subject matter as well as an outlined course of study.

It may be said that "Change—in the organism and the environment" is the basic theme of this book. In order to explain the mechanics and significance of these changes, the author has consistently presented a simple rationale of "health behavior" that should make the book's health directives more acceptable to the student.

JOE E. METTLER

ENJOYING HEALTH. *Second Edition.*

By Evelyn G. Jones. J. B. Lippincott Company, Chicago, Philadelphia, and New York. $4.12. xii + 434 pp.; ill. 1956.

It is difficult to find in this book any two consecutive pages that display neither pictures nor diagrams. The author presents the book as a guide for high school students in forming, or modifying, their "health habits and attitudes." Thus, an understanding of underlying principles—of physiology, biology, etc.—is not emphasized.

The 23 chapters of the book are divided among 5 units whose headings consist of topical questions reflecting "the findings of the Denver study of health interests of children": How can I become the person that I want to be? How can I keep in good condition? How can I improve my appearance? How can I be a worth-while and likeable person? What helps do I have in keeping well?

Although, through pictures, lists of suggested activities and visual aids, and a personalized style of writing, the author upholds the recently popular, pre-sputnik attitude of consigning plain-faced "fact learning" to anathema, there is probably sufficient information, presented obliquely, in this book to meet the needs of the courses for which it was intended.

JOE E. METTLER

ECOLOGY AND NATURAL HISTORY

BIOGEOGRAPHY. *An Ecological Perspective.*

By Pierre Dansereau. The Ronald Press Company, New York. $7.50. xiii + 394 pp.; ill. 1957.

It is the objective of this book to provide senior and graduate students in the fields of animal ecology, geography, genetics, anthropology, and social sciences with a new synthesis of relationships of living organisms. It is also the hope of the author that the volume will invite the attention of natural scientists in search of an ecological inventory. The plan of the book follows

certain implications which are here quoted from the Preface:

1. The floristic group (or element) and the vegetation zone to which a species or a community belong have, in the course of time, conditioned their adaptation, often more narrowly or more broadly than the present environment seems to allow.

2. The plant association, as defined, is a truly adaptive unit which bears internal cohesion structurally and floristically.

3. The factors of the habitat, taken in their actual conjunction, exert the only real limiting power upon individual organisms and whole communities.

4. Ecological processes are everywhere at work, and tend to develop a series of equilibria which present various degrees of stability. These processes may be inhibited or accelerated.

5. Natural selection, which is both conserving and innovating, operates at the community level (or below) and can only be understood if the biocenosis is considered as the matrix upon which organic evolution develops.

The environmental processes and relationships are studied and discussed at five levels of integration: with reference to their geological history, their present climatological background, their synecology, their autecology, and their responses to man's exploitation. Each one of these represents a chapter in the book. The details, terms, and references, with which the book is replete, are presented primarily to document the broad generalizations and synthesis which the author proposes and also to provide case histories for the "laws," which are enunciated at the end of each chapter. As is to be expected, since the author is a botanist, the treatment is predominantly botanical, and animals receive only token acknowledgment. It is rather unfortunate that a book with such broad aims is restrictive. It is questionable that the laws enunciated, primarily on the basis of botanical studies, have any validity in the broad biological sense. This is probably the greatest weakness of the book. It is also a very difficult book to read because of the style of writing and the terminology; for example, "By application to a variety of ecological situations all over the world, it is possible to test the various conjunctions of their potentially antagonistic forces and to detect their modus operandi at several successive levels." Comprehension of many of the ideas might have been enhanced by more concise writing. However, this book does contain an abundance of information of an authoritative nature, and the ideas expressed are thought-provoking. For its high stimulatory value it should be consulted by anyone interested in geography or ecology.

V. G. DETHIER

FAUNA AND FLORA OF THE SEAS OF THE USSR. *Second Edition.*

By L. A. Zenkevich. Uchpedgiz, Moscow. 12 rubles 35 kopeks. 424 pp. + 8 col. pl.; text ill. 1956.

This second edition has been completely reset in clearer type, and revised (the first edition had 305 pages), with many new text figures and addition of color plates and end papers (a map of the USSR with embellishments). A better grade of paper has been used. The most interesting addition is a section on Our Far-Eastern Seas, summarizing the recent investigations by the "Vitiaz" in the Kurile-Kamchatka trench and the Sea of Okhotsk. A work of this character, published in such a large edition (20,000 copies), indicates a lively interest in marine biology in the Soviet Union.

JOEL W. HEDGPETH

THE NORTH AMERICAN DESERTS.

By Edmund C. Jaeger. Stanford University Press, Stanford. $5.95. vii + 308 pp.; ill. 1957.

It is difficult to travel to the west coast of the United States or to many points in Mexico without traversing one of the five American Deserts. They occupy a considerable portion of the western and southwestern parts of the United States, and the western and north-central areas of Mexico. This volume is best described as a guide to these regions. Introductory chapters deal with rainfall, temperature, and other climatic conditions which are necessary for a geographical area to be called a desert. The author devotes a chapter each to the Chihuahuan, Mojave, Great Basin, and Painted deserts. The vast Sonoran desert is divided into 6 subdivisions, each of which is discussed in separate chapters. The geographical boundaries, topography, climate, geologic history, flora, and fauna are comprehensibly and simply presented for each desert and subdivision. The last half of the book consists of 355 line drawings and brief descriptions of the insects, reptiles, birds, mammals, and plants most common to the desert regions. Over 30 excellent photographs, and several maps and tables are included. The bibliography is divided into general references and references pertaining to the individual deserts. The text is written in an easy, flowing style. Although it is a scientific presentation, it must be considered as written for the general reader. The book is recommended as a guide for the travelers or residents of the deserts, while it should also serve as a reference work for the serious student of ecology.

LAWRENCE E. METTLER

OF MEN AND MARSHES.

By Paul L. Errington; illustrated by H. Albert Hoch-

baum. The Macmillan Company, New York. $4.50. ix + 150 pp.; ill. 1957.

Errington is a wildlife zoologist whose special interests lie in the area of population dynamics. This book clearly reflects the fact that it has been written by a man of scientific training, wide experience, and understanding of wetlands and their inhabitants. Particular attention is given to the native inhabitants of the natural marshes occurring over the glaciated prairies of the north-central United States and Canada. Some reference is also made to the marshes of the South and the desert marshes of the West. The book is handsomely illustrated.

The author is not only adept in creating vivid descriptions of marsh-dwelling animal societies but is also convincing in his argument that man should not destroy unnecessarily the remnants of our still undrained marshlands.

SCOTT S. PAULEY

ANIMAL ECOLOGY. *Aims and Methods. Zoology Series.*

By A. Macfadyen. Sir Isaac Pitman & Sons, London. 40s. xx + 264 pp. + 6 pl; text ill. 1957.

This book has been written particularly for the naturalist, the student, and the layman who want to know what ecology is about. It "claims neither to offer a comprehensive treatment nor to cater simply for the elementary student. Its scope is at once wider and more limited; limited to a few special problems and unashamedly more one-sided, but wider for the very reason that these problems are considered in a broader and more critical way." Having thus stated his motives, the author proceeds to present his book in 3 major divisions: the ecology of individuals; animal population ecology; and the properties of animal communities. In the first part he discusses briefly the importance of taxonomy to the ecologist and the imperfections of the current system. A discussion of habitat begins with four examples followed by generalizations. A chapter on microclimates skims over this topic and concludes with some information on methodology. The remainder of Part One is concerned with the relation between plant and animal ecology and an unconvincing justification for the separate study of the two. A chapter on the distribution of animals in space and time follows. Part Two contains chapters on collection methods, estimation of animal numbers, demography, the productivity of populations, and the activity of populations. Part Three is devoted to the interrelations of populations, intraspecific relationships, population dynamics, the application of population dynamics, the detection and delimitation of communities, the community, and ecology and human problems.

This book has an approach decidedly different from most current ecological works. In striving to provide an introduction to the objectives of the ecologist and to provide a justification for regarding ecology as a subject in its own right, the author has understandably had to sacrifice a certain amount of detail, and the brevity of treatment in some sections is somewhat irritating. While it is true that the interested reader can consult the very satisfactory reference list for additional information, this brief and rapid treatment frequently whets the appetite in too tantalizing a fashion. One is left with a feeling that he is being sped in undue haste from one topic to the next, and the relations are not always readily apparent. Furthermore, a great deal of information has been crammed into a small amount of space. In many places, however, the approach is refreshingly different from standard treatments. Whether or not the author has succeeded in providing the layman and the student with an introduction to the objectives and methods of ecology remains to be seen. I am personally left with the impression that the book is best suited to introduce ecology to other scientists.

V. G. DETHIER

THE CLIMATE NEAR THE GROUND. *Second Printing, Revised.*

By Rudolf Geiger; translated by Milroy N. Stewart and others. Harvard University Press, Cambridge. $6.00. xxi + 494 pp.; ill. 1957.

This excellent book needs no introduction for those who have had any interest in climatological or ecological problems. It remains the only comprehensive and authoritative text on microclimatology. The present English edition is a translation of the second German edition of *Das Klima der Bodennehen Luftschicht*, with revisions and enlargements by the author. In addition to extending the first edition and augmenting its bibliography, the author has now added a supplementary bibliography of 7500 items to include references up to 1954. This new edition contains a wealth of information for biologists interested in physical factors of the environment. All ecologists should read it.

V. G. DETHIER

INSECT LIFE IN THE TROPICS.

By T. W. Kirkpatrick. Longmans, Green & Company, New York. $7.00. xiv + 311 pp.; ill. 1957.

Those seeking a readable, original, and not very detailed account of odd life histories, behavior, and habits of insects, especially of tropical forms, and who do not require much in the way of physiological or ethological interpretation, will be pleased with *Insect Life in the Tropics*. Addressed more to an audience interested in general natural history than to professional entomologists, it is notable in the care and objectivity of its lucid and graceful prose, wholly unmarred by the florid

inanities which insects seem to call forth from their popularizing enthusiasts.

The book is handsomely made and printed in clear type on high gloss paper. Almost certainly those who take it to the tropics would therefore do well to keep it dry and to treat its covers in the manner described on p. 150. Topically the book treats of: the tropical environment (4 pp.), the general structure of insects (18 pp.), classification (31 pp.), development (20 pp.), reproduction (30 pp.), locomotion (16 pp.), food and feeding habits (77 pp.), defense and protection (40 pp.), insect architecture (19 pp.) and, finally, insect communities (42 pp.). Most of the 146 illustrations are of good to very good quality, and the index (12 pp.) is satisfactory; there is no bibliography. Regrettably, the few references scattered through the text will be of little help to any readers who wish to learn more of the many interesting cases discussed.

Despite its title and goal, the book is not likely to provide a satisfactory characterization of insect life in the tropics, at least not to the uninitiated. For one thing, it is probably impossible to gain an overall view of tropical insects without a fair understanding of insects as such, and without at least an atlas of figures that will give a fair impression of the variety of forms and characteristic types under discussion. The short section on morphology (and physiology) is hardly adequate, and that on classification—as Kirkpatrick realizes—will probably be of negligible help to either novice or professional reader. The characterizations are often uninformative, and some are careless. There are few, for example, who would examine wing *venation* to distinguish Stratiomyidae from wasps and bees, which they superficially resemble.

Nevertheless, the main portion of the book provides a good introduction to the activities, habits, and behavior of insects at a descriptive level. A good many of the observations have been made at first hand, or corroborated, by the author, and accordingly insects of Trinidad and East Africa, and less so those of the Sudan and Egypt, are given particular attention. Perhaps, because this book is so enriched with personal experience, certain topics and peculiar forms such as dulce de avispa, trigonalid life histories, railroad bugs and tropical army worms, *Pseudomyrma* and the acacias, and so on, are not touched upon; nor is much text devoted to insects of medical interest. But there are many interesting cases not likely to prove familiar to most readers. For example, there is an account of a moth, *Fulgoraecia*, whose eggs of a given laying hatch progressively over a period extending to 4 years, of the stylopid *Corioxenus* whose female requires two genital openings, of a blind snake *Typhlops* said to accompany the driver ant *Dorylus*, and so on.

Kirkpatrick has clearly enjoyed his wide entomological experience in the tropics, and the book everywhere pleasantly reflects this, no less than his extensive knowledge of natural history and his skill of exposition. Within the limitations described, this is an interesting and informative book for the lay reader and entomologist alike.

KENNETH W. COOPER

EVOLUTION

PERMIAN GASTROPODA OF THE SOUTHWESTERN UNITED STATES. *1. Euomphalacea, Trochonematacea, Pseudophoracea, Anomphalacea, Craspedostomatacea, and Platyceratacea. Bull. Amer. Mus. nat. Hist., Vol. 110, Art. 3.*

By Ellis L. Yochelson; with a section on the Effect of the Crinoid Host on the Variability of Permian Platyceratids, by Arthur L. Bowsher. American Museum of Natural History, New York. $2.00 (paper). Pp. 173–276 + 1 table + 16 pl.; text ill. 1956.

With the exception of a few species, the Permian gastropods of the southwestern United States have not been studied heretofore. The present work gives a systematic description of 6 superfamilies of Permian gastropods from western Texas and is the beginning of a series planned by Knight, Batten, and Yochelson to deal with the gastropods of the Permian system in the southwestern United States.

The main part of the material considered comes from a limestone the fossils of which are silicified. By treatment with hydrochloric acid, the matrix is easily leached away. This task was undertaken by the liberal collecting and etching program of the United States National Museum and the American Museum of Natural History. Most of the gastropods described in the report have been taken from the residue of 45 to 50 tons of limestone! In addition, smaller collections of non-silicified specimens have been included. The American forms are not compared with each of the foreign species because in many cases it is very difficult to describe the specific characters of gastropods and because foreign material was not available for study.

The large systematic part gives the diagnosis of 6 superfamilies (see subtitle of the monograph), covering the families Euomphalidae, Omphalotrochidae, Trochonematidae, Pseudophoridae, Anomphalidae, Craspedostomatidae, and Platyceratidae.

The following genera or subgenera heretofore known are rediagnosed: *Straparollus* (*Euomphalus*), *Amphiscapha* (*Amphiscapha*), *Omphalotrochus*, *Cyclites*, *Anomphalus*, *Brochidium*, and *Platyceras* (*Orthonychia*). New genera or subgenera are: *Amphiscapha* (*Cylicioscapha*, *Straparollus* (*Leptomphalus*), *Planotectus*, *Babylonites*, *Discotropis*, *Diploconula*, *Sallya*, and *Dichostasia*.

More than 30 new species are described and these seem to be "sound." The quantity of specimens comprehended in a single species shows that variation has been respected. For example, the author has taken

534 specimens as a basis for the description of *Platyceras* (*Orthonychia*) *bowsheri* n. sp. The descriptions of species are exact and easy to survey. The list of synonymy is followed by a short diagnosis and a detailed description. The reader will be especially grateful for the discussion illustrating the difference between the species in question and allied species (the Differentialanalyse recommended by Richter, 1948). Finally, the number of specimens studied, their state of preservation, horizon, and locality are indicated. The figured and some unfigured but significant specimens have been listed under "numbered specimens." Statistical measurements have not been used to compare species because even seemingly excellent specimens have been crushed.

An Appendix by A. L. Bowsher considers The Effect of the Crinoid Host on the Variability of Permian Platyceratids. The extreme variety in size and shape of platyceratids is caused by their habit. They are thought to have been coprophagous because of their occurrence on the anal vent of crinoids. Therefore to some extent their shape is a result of the contour of the host with which they are symbiotic. This fact must be considered in taxonomic study. The shape of the aperture of a platyceratid signifies to what type of crinoid it was attached. *Platycrinites*, *Calceolispongia* or *Eutelocrinus*, *Cromiocrinus*, and *Ulocrinus* are discussed as possible hosts of Permian gastropods. A conclusive answer is to be expected after the crinoids of the localities which have yielded the gastropods in question have likewise been studied.

K. VOGEL

POST-TRIASSIC NAUTILOID GENERA. *Bull. Mus. comp. Zool., Vol. 114, No. 7.*

By Bernhard Kummel. Museum of Comparative Zoology, Harvard College, Cambridge. $2.75 (paper). v + pp. 324–494 + 28 pl.; text ill. 1956.

The present work gives a comprehensive discussion of the evolution and classification of post-Triassic nautiloids. The nautiloids experienced their greatest expansion in the Ordovician. In the Silurian there was already a decline, which continued nearly to the extinction of the subclass at the end of the Triassic. Only one group derived from the Triassic Syringonautilidae survived into the Jurassic: the group *Cenoceras*. It is from this stock that all the later nautiloids evolved. In the history of ammonoids, and many other groups too, the end of the Triassic is a period of extreme contraction or extinction.

Concerning the taxonomic arrangement, the author has adopted the 5 families described by Spath (1927), but he has considered them to constitute only a single family, the Nautilidae. He has added a new subfamily, the Pseudaganidinae.

The author studies the evolution of nautiloids at the generic level. Because of their scarcity, the variability of nautiloids is unknown, and all the so-called species (more than 500) of earlier authors are only descriptions of individuals.

It is one of the 27 genera described (*Dellocymatoceras* and *Epicymatoceras* being new genera) which is especially of general interest. This is *Cenoceras*, from which all later nautiloids were derived, a genus worldwide in the Lias and of the widest range of variation. Kummel says: "A precise morphological definition of *Cenoceras* is not possible because of the wide variability and range in conch shape and ornamentation." And elsewhere: "To bring the taxonomy of these nautiloids to reflect the phylogenetic interpretation, all of the genera previously proposed for aberrant types in the Liassic are placed in synonymy of *Cenoceras*." But in regard to the position taken in the two sentences cited, I would ask: *Is* a genus without a morphological definition really a valid genus? The taxonomy is not permitted to be a consequence of a phylogenetic interpretation. Taxonomy and phylogeny must rest only on exact morphological results. Furthermore, the descriptions of the other genera would have been less difficult to survey, if the author had given a short and clear morphological definition before discussing the phylogeny.

The work of the author is an outgrowth of his chapter on the Mesozoic nautiloids in the *Treatise on Invertebrate Paleontology* edited by R. C. Moore. The present comprehensive discussion is illustrated by many figures showing cross sections, sutures, maps of the geographic distribution of species, and by 28 plates with views of the types.

K. VOGEL

CRETACEOUS SYSTEM IN NORTHERN PERU. *Bull. Amer. Mus. nat. Hist., Vol. 108, Art. 4.*

By Victor E. Benavides-Cáceres. American Museum of Natural History, New York. $3.50 (paper). Pp. 353–494 + 36 pl.; text ill. 1956.

"The purpose of this paper is: (1) to describe the Cretaceous succession in the Andes of northern Peru, establishing standard sections of reference and fossil zones; (2) to describe its cephalopod faunas and their stratigraphic distribution; and (3) to summarize the geological history of the area during the Cretaceous."

The Cretaceous sediments rest unconformably on older systems. The Lower Cretaceous to the Aptian consists preponderantly of sandstones and brackish sediments (2000 meters). In the Lower Albian in the west of the Marañón valley the true marine transgression begins, the Inca and Pariahunca formations showing the changing facies. In the Middle Albian the accumulation of organic matter gives rise to the black limestones of the Pariatambo formation, which

is rich in ammonites. In the Rio Marañón region in the Lower Albian, deposition of quartz-sandstones is still prevailing; from the Upper Albian and Lower Cenomanian this region is eroded, but then the sea enters, and the Turonian is marine. In the fossiliferous Coniacian the sea becomes more shallow and even precipitates gypsum. The Santonian is characterized through orogenetic elevation and the accumulation of the red flysch deposits of the Chota formation. An index of 13 zones, 2 of which are founded on the Ostreidae and the others on ammonites, and many profiles, are given.

The ammonite fauna (70 species, 24 of them new) is completely and accurately figured and described. Phylloceratids are wanting; lytoceratids are represented only by some aberrant forms. Over and above the other ammonites the so-called "pseudoceratites" predominate. The fauna belonging to the realm Peru, Colombia, Venezuela, and Brazil shows many similarities and parallels with Mexico and with the Mediterranean and South Asiatic faunas of the Tethys. Only the genus *Buchiceras* sensu stricto is limited to South America, but many species restricted to South America give to this fauna its special character.

The studied families (without the lytoceratids) are as follows: Olcostephanidae (only the genus *Valanginites*), Desmoceratidae, Parahoplitidae (genus *Parahoplites*), Douvilleiceratidae (*Douvilleiceras*), Schloenbachiidae (*Forbesiceras*), Engonoceratidae, Dipoloceratidae, Lyelliceratidae (*Lyelliceras*), Acanthoceratidae (*Acanthoceras*), Mammitidae, Vascoceratidae, Peroniceratidae (*Texanites*), Coilopoceratidae (*Coilopoceras*), Tissotiidae, Lenticoceratidae (*Lenticoceras*), and *Neolobites* incertae sedis.

H. HÖLDER

THE MIDLAND DISCOVERY. *A Report on the Pleistocene Human Remains from Midland, Texas.*

By Fred Wendorf, Alex D. Krieger, and Claude C. Albritton; with a description of the skull, by T. D. Stewart. University of Texas Press, Austin; published in cooperation with the Museum of New Mexico. $3.50. viii + 139 pp.; ill. 1955.

Part of a human skeleton was discovered by Keith Glasscock in a late Pleistocene deposit 6 miles southwest of Midland, Texas, in June, 1953. Wendorf and Krieger believe that available evidence very strongly indicates its age as being considerably older than the famous Folsom lithic culture, and hence antedating the last major advance of the North American ice sheets. Thus Midland man lived before the close of the Pleistocene, although existing techniques are not capable of determining his precise age. Various chemical tests indicate his contemporaneity with several species of extinct, Pleistocene animals.

The authors give good descriptions of the geography and geology of the area and of the worked localities and their associated artifacts. No artifacts were found in association with the human skeletal remains, but a variety of worked lithic tools have been recovered at this and nearby localities. There is no proof, however, that any of these are contemporaneous with the human remains.

The human skeletal remains have been described by Stewart. Part of the skull, consisting of most of the calvarium, is represented; this was recovered in some 130 separate pieces and has been skilfully reconstructed. All parts of face and jaws are lacking. Parts of at least 2 metacarpals, a rib, and a few upper teeth were also found. The skull, which is of an Amerind type, appears to be that of a female around 30 years of age. Perhaps its most notable feature is its elongated shape; no other American skull with a good claim to antiquity is so relatively longheaded.

This careful study of an important find provides a welcome antidote for some of the inspirational hunches that still plague paleoanthropology.

W. L. STRAUS, JR.

NATURAL SELECTION IN MAN. *Papers of the Wenner-Gren Supper Conference, held at the University of Michigan, April 12, 1957, during a meeting of the American Society of Human Genetics and the American Association of Physical Anthropologists.*

Arranged by J. N. Spuhler. Wayne State University Press, Detroit. $3.50. vi + 72 pp.; ill. 1958.

GENETICS AND CYTOLOGY

BILATERAL POLYCYSTIC DISEASE OF THE KIDNEYS. *A Follow-Up of Two Hundred and Eighty-Four Patients and their Families.*

By O. Z. Dalgaard. Ejnar Munksgaard, Copenhagen. D. Kr. 29.—(paper). 255 pp. + 7 pl.; text ill. 1957.

This monograph, also published as a supplement to *Acta Medica Scandinavica* (vol. 158, 1957), joins the group of distinguished treatises on particular hereditary disorders which have come out of Copenhagen. Although it is not one of the series of monographs from Professor Tage Kemp's Institute of Human Genetics, its author was assisted and advised by Kemp and other members of the Institute. Like most of the other studies from Copenhagen, complete ascertainment was attempted. The number of probands is impressive; the scope of the study is further indicated by the fact that 211 close relatives of propositi cooperated in having intravenous urography.

The frequency of polycystic kidneys at autopsy in adults over 15 years of age was 1773. "The malformation appears so infrequently in children that it must be

considered as a curiosity." Two genotypes are suggested. In the more frequent variety the disease becomes manifest in adulthood and is inherited as an autosomal dominant. In the rare "congenital" variety, fatal at an early age, inheritance is as an autosomal recessive. (Two analogous forms of osteogenesis imperfecta have been proposed.) It is to the latter type that the author restricts the designation *congenital* cystic disease of the kidneys.

The average age of death from the adult form of cystic renal disease was 51.5 years, with a range of 25 to 85 years. In 173 autopsies, liver cysts were found in 64. Polycystic liver disease occurs rarely except in combination with cystic kidney disease, which dominates the clinical picture. The author's experience suggests that the *Rovsing* operation for multiple puncture of cysts accomplishes very little in the treatment of this disease.

Genealogical investigations were possible in the case of 232 probands. Although only 15 cases were reported as familial in the hospital and other records, the author's studies identified a total of 162 as actually familial, leaving 70, or about 30% as apparently sporadic.

The trait under study seemed to be fully penetrant. Dalgaard used the method of Nyholm and Helweg-Larsen for computing morbid risk, or disease expectancy, which varies with age. The risk percentage for siblings at the age of 80 years reaches 49.7 per cent, 50% being the expected value for a dominant trait. An intra-familial correlation for age of diagnosis was demonstrably higher than inter-familial correlation. No support for "anticipation" was discovered. By Haldane's indirect method the spontaneous mutation rate was estimated at a value between 6.5 and 12 $\times$ 10^{-4} mutations per gene per generation.

Intracranial aneurysm, a postulated pleiotropic effect of the gene under study, occurred with doubtfully increased frequency in this group. There were only 7 cases of subarachnoid hemorrhage in the group of 173 autopsies. No linkage with seven blood group systems was demonstrated.

VICTOR A. MCKUSICK

GENERAL AND SYSTEMATIC BOTANY

HOW TO KNOW WESTERN AUSTRALIAN WILDFLOWERS. *Part II: A Key to the Flora of the Temperate Regions of Western Australia.*

By William E. Blackall and Brian J. Grieve. The University of Western Australia Press, Nedlands. 30s. lvi + pp. 322–459 + 19 pl.; text ill. 1957.

In spite of the fact that this book probably has more information about western Australian wildflowers than most people living in this hemisphere will need to know, it does, nevertheless, illustrate a valuable technique that might well be copied by writers of field manuals anywhere.

The book consists, first of all, of a dichotomous key to the families done in the traditional manner. The keys to genera, sections, and species that follow, however, have the critical points of difference between the alternatives illustrated by detailed drawings. For the amateur naturalist or even the professional botanist of limited taxonomic experience, the method must certainly be extremely helpful. An illustrated glossary and index of scientific names completes the volume.

Part I of this manual, using the same illustrated key method, was published in 1954. Part I provides keys to 2500 species; the present volume includes an additional 500 species.

SCOTT S. PAULEY

STUDIES ON THE VASCULAR FLORA OF THE PROVINCE OF NEWFOUNDLAND (CANADA). I. THE GENUS *DRYAS* (ROSACEAE) IN NEWFOUNDLAND. II. SOME NEWFOUNDLAND VERNACULAR PLANT NAMES. III. A CHECKLIST OF THE VASCULAR PLANTS OF THE PROVINCE OF NEWFOUNDLAND (*including the French Islands of St. Pierre and Miquelon*). *Contr. Inst. bot. Univ. Montréal, No. 69.*

By Ernest Rouleau. Institut Botanique de l'Université de Montréal, Montréal. $1.00 (paper). 106 pp.; ill. 1956.

PLANT MORPHOLOGY AND DEVELOPMENT

THE GROWTH OF LEAVES. *Proceedings of the Third Easter School in Agricultural Science, University of Nottingham, 1956.*

Edited by F. L. Milthorpe. Butterworths Scientific Publications, London; Academic Press, New York. $6.80. x + 223 pp.; ill. 1957.

This little book records the proceedings of the Third Easter School in Agricultural Science held at the University of Nottingham in 1956. Realizing that crop yield is in large measure determined by the amount of photosynthetic or leaf surface the crop plants produce, the organizers of the conference made an understanding of the inception and subsequent development and growth of leaves their main objective.

The proceedings are divided into 5 parts dealing with general aspects of growth and differentiation, initiation of leaf primordia, leaf expansion, the influence of external forces on leaf growth, and short papers or demonstrations. This last part is mostly in the form of abstracts, and one might wonder if it merits publication in book form. The editor of any book representing proceedings of a symposium or conference, however, is justified in making the record complete. As expected,

the major papers vary considerably in the manner and directness with which they treat the main problem of the meetings. Thus, one papers deals with root growth, another with the role of polarity in differentiation; some papers report studies essentially morphological, others physiological, others mathematical, and some ecological in nature. This variety undoubtedly adds interest to the book, as do the discussions which occurred after each presentation. The potential reader should not expect to find here a thorough consideration of all aspects of leaf growth. He will find, however, a lively treatment of these aspects by men who, through their research, are in close contact with them.

CARLOS MILLER

ECONOMIC BOTANY

PRINCIPLES OF PLANT PATHOLOGY.

By E. C. Stakman and J. George Harrar. The Ronald Press Company, New York. $8.00. xi + 581 pp.; ill. 1957.

This is no ordinary plant pathology book. Anyone in search of the usual encyclopedic account of a given disease, with its definition, host range, consideration of etiologic agent, symptoms, and control will be disappointed. Unlike most books with the word "Principles" in the title, this book actually deals with principles. The authors have wisely focused their primary attention on diseases of food crops, particularly cereals, and on those diseases of wide distribution, such as the rusts and smuts.

The outstanding chapters are in my opinion those on the genetics of plant pathogens and on plant diseases of international importance, reflecting particular and long-standing interests of the authors. The impact of diseases such as banana wilt, coffee rust, and leaf blight of rubber, to name but a few, upon human affairs and history is but little appreciated by the general public. Because plant diseases recognize no national boundaries, an impressive array of international organizations is now dealing with plant disease problems which, even in a country whose agriculture is well developed, as in the United States, are responsible for annual losses of three billion dollars.

This book will mark a milestone in plant pathology. Well written, beautifully illustrated, well indexed, and unusually free of errors, it will be of value to plant pathologists for years to come.

FREDERICK T. WOLF

ATOMIC ENERGY AND AGRICULTURE. *Symposium presented on Dec. 27–29, 1955 at the Atlanta Meeting of the AAAS and co-sponsored by the Oak Ridge Inst. of Nuclear Studies, under contract with the U. S. Atomic Energy Commission. Publ. 49.*

Edited by C. L. Comar. American Association for the Advancement of Science, Washington, D. C. $9.50; $8.25 (AAAS Members). x + 450 pp.; ill. 1957.

During the past decade atomic energy has been a valuable tool in solving many problems in applied and fundamental research in agriculture. This book presents a well-organized account of many of the important contributions which radioisotopes and high-energy radiation have already made to research directed toward improving the art and technology of food production and processing. To a limited extent, the symposium touches on the use of these forms of atomic energy in solving fundamental problems in agricultural research.

The book comprises 22 papers, primarily reviews. They cover just about every field of agricultural research which has benefited from atomic energy. Most chapters appraise past accomplishments and future potentialities of this research tool in various fields. It is worth noting that not all fields of agricultural research have yet applied this tool to the same degree. For instance, atomic energy is widely used in plant and animal metabolism research, whereas it has been applied far less in soil physics and in research on soil-plant relations.

The authors are American scientists considered to be leaders in their particular areas. Most of the papers are well documented with up-to-date literature citations from journals published in this and other countries. Over 1000 references, mostly published since 1950, are given.

The first 5 papers (by M. Fried; L. E. Ensminger and R. W. Pearson; D. W. Thorne and H. H. Wiebe; G. W. Burton; W. A. Raney and M. D. Thorne) are concerned with the application of radioisotopes to elicit a greater understanding of soil-plant relations. They emphasize the measurement of plant nutrient levels in the soil, the movement of plant nutrients within the soil, uptake and exchange phenomena, evaluation of native fertility, distribution patterns of the various elements in plants, fertilizer management, root development, and soil physics.

The next 5 papers (by N. E. Tolbert; R. MacVicar; C. A. Swanson; S. H. Wittwer; J. W. Mitchell and P. J. Linder) deal with plant metabolism research. These are quite detailed and are primarily concerned with the application of radioisotopes to the study of photosynthesis, the metabolism of the important nitrogen-containing compounds, the translocation of organic nutrients in plants, the mechanism of foliar absorption, the intake and movement of plant growth regulators through the plant, and the control of plant processes through these regulators.

The next paper (by W. R. Singleton) outlines the use of high-energy radiation to create genetic variability in crop plants for use in plant improvement programs. This is followed by a paper (by D. W. Jenkins) dealing with the use of radioisotopes and high-energy radiation in entomological research. It presents a very detailed

considered as a curiosity." Two genotypes are suggested. In the more frequent variety the disease becomes manifest in adulthood and is inherited as an autosomal dominant. In the rare "congenital" variety, fatal at an early age, inheritance is as an autosomal recessive. (Two analogous forms of osteogenesis imperfecta have been proposed.) It is to the latter type that the author restricts the designation *congenital* cystic disease of the kidneys.

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Edited by F. L. Milthorpe. Butterworths Scientific Publications, London; Academic Press, New York. $6.80. x + 223 pp.; ill. 1957.

This little book records the proceedings of the Third Easter School in Agricultural Science held at the University of Nottingham in 1956. Realizing that crop yield is in large measure determined by the amount of photosynthetic or leaf surface the crop plants produce, the organizers of the conference made an understanding of the inception and subsequent development and growth of leaves their main objective.

The proceedings are divided into 5 parts dealing with general aspects of growth and differentiation, initiation of leaf primordia, leaf expansion, the influence of external forces on leaf growth, and short papers or demonstrations. This last part is mostly in the form of abstracts, and one might wonder if it merits publication in book form. The editor of any book representing proceedings of a symposium or conference, however, is justified in making the record complete. As expected,

the major papers vary considerably in the manner and directness with which they treat the main problem of the meetings. Thus, one papers deals with root growth, another with the role of polarity in differentiation; some papers report studies essentially morphological, others physiological, others mathematical, and some ecological in nature. This variety undoubtedly adds interest to the book, as do the discussions which occurred after each presentation. The potential reader should not expect to find here a thorough consideration of all aspects of leaf growth. He will find, however, a lively treatment of these aspects by men who, through their research, are in close contact with them.

CARLOS MILLER

ECONOMIC BOTANY

PRINCIPLES OF PLANT PATHOLOGY.

By E. C. Stakman and J. George Harrar. The Ronald Press Company, New York. $8.00. xi + 581 pp.; ill. 1957.

This is no ordinary plant pathology book. Anyone in search of the usual encyclopedic account of a given disease, with its definition, host range, consideration of etiologic agent, symptoms, and control will be disappointed. Unlike most books with the word "Principles" in the title, this book actually deals with principles. The authors have wisely focused their primary attention on diseases of food crops, particularly cereals, and on those diseases of wide distribution, such as the rusts and smuts.

The outstanding chapters are in my opinion those on the genetics of plant pathogens and on plant diseases of international importance, reflecting particular and long-standing interests of the authors. The impact of diseases such as banana wilt, coffee rust, and leaf blight of rubber, to name but a few, upon human affairs and history is but little appreciated by the general public. Because plant diseases recognize no national boundaries, an impressive array of international organizations is now dealing with plant disease problems which, even in a country whose agriculture is well developed, as in the United States, are responsible for annual losses of three billion dollars.

This book will mark a milestone in plant pathology. Well written, beautifully illustrated, well indexed, and unusually free of errors, it will be of value to plant pathologists for years to come.

FREDERICK T. WOLF

ATOMIC ENERGY AND AGRICULTURE. *Symposium presented on Dec. 27–29, 1955 at the Atlanta Meeting of the AAAS and co-sponsored by the Oak Ridge Inst. of Nuclear Studies, under contract with the U. S. Atomic Energy Commission. Publ. 49.*

Edited by C. L. Comar. American Association for the Advancement of Science, Washington, D. C. $9.50; $8.25 (AAAS Members). x + 450 pp.; ill. 1957.

During the past decade atomic energy has been a valuable tool in solving many problems in applied and fundamental research in agriculture. This book presents a well-organized account of many of the important contributions which radioisotopes and high-energy radiation have already made to research directed toward improving the art and technology of food production and processing. To a limited extent, the symposium touches on the use of these forms of atomic energy in solving fundamental problems in agricultural research.

The book comprises 22 papers, primarily reviews. They cover just about every field of agricultural research which has benefited from atomic energy. Most chapters appraise past accomplishments and future potentialities of this research tool in various fields. It is worth noting that not all fields of agricultural research have yet applied this tool to the same degree. For instance, atomic energy is widely used in plant and animal metabolism research, whereas it has been applied far less in soil physics and in research on soil-plant relations.

The authors are American scientists considered to be leaders in their particular areas. Most of the papers are well documented with up-to-date literature citations from journals published in this and other countries. Over 1000 references, mostly published since 1950, are given.

The first 5 papers (by M. Fried; L. E. Ensminger and R. W. Pearson; D. W. Thorne and H. H. Wiebe; G. W. Burton; W. A. Raney and M. D. Thorne) are concerned with the application of radioisotopes to elicit a greater understanding of soil-plant relations. They emphasize the measurement of plant nutrient levels in the soil, the movement of plant nutrients within the soil, uptake and exchange phenomena, evaluation of native fertility, distribution patterns of the various elements in plants, fertilizer management, root development, and soil physics.

The next 5 papers (by N. E. Tolbert; R. MacVicar; C. A. Swanson; S. H. Wittwer; J. W. Mitchell and P. J. Linder) deal with plant metabolism research. These are quite detailed and are primarily concerned with the application of radioisotopes to the study of photosynthesis, the metabolism of the important nitrogen-containing compounds, the translocation of organic nutrients in plants, the mechanism of foliar absorption, the intake and movement of plant growth regulators through the plant, and the control of plant processes through these regulators.

The next paper (by W. R. Singleton) outlines the use of high-energy radiation to create genetic variability in crop plants for use in plant improvement programs. This is followed by a paper (by D. W. Jenkins) dealing with the use of radioisotopes and high-energy radiation in entomological research. It presents a very detailed

review of the aid radioisotopes can give in furthering understanding of the biology, migration, physiology, biosynthesis, and control of insects and insect transmission of disease.

The next 4 papers (by G. K. Davis; C. L. Comar and R. H. Wasserman; J. C. Shaw and S. Lakshmanan; J. A. Stekol) deal with the application of radioisotopes in animal nutrition and metabolism research. Here are included studies in animal metabolism using radioactive micro- and macro-nutrients. This series includes a good review of the role of radioisotopes in research on the formation of milk fat, protein, and carbohydrate, and on milk secretion in general. The final paper of this series reviews amino acid synthesis in animals. It points out how radioisotopes can provide a key to the understanding of the operation of interconversion pathways of metabolites in the intact animal.

The last 6 papers (by H. R. Kraybill; B. E. Proctor and S. A. Goldblith; L. E. Brownell, J. V. Nehemias, and S. N. Purohit; B. C. Johnson; M. S. Read and H. F. Kraybill; R. G. H. Siu) discuss high-energy radiation sterilization of food and emphasize research to determine what radiation facilities are needed for radiation sterilization on a large scale, research on toxic substances produced by radiation, on biochemical effects of radiation, on economic effects of food irradiation, and on the wholesomeness and acceptability of the final product.

In my opinion, the following aims of the volume, as stated by the editor, have been accomplished, namely, to "serve the administrator, research worker, and student by providing (a) an organized and realistic picture of the state of the science, (b) a critical examination of past work with enough specific examples to give tangible information, (c) suggestions for profitable areas of future research, and (d) stimulation of interest in novel techniques and approaches to important problems."

One cannot help but be fascinated by the possibilities of further research in agricultural production with the aid of radioisotopes and high-energy radiation. This volume shows the way to many of these possibilities.

R. A. NILAN

FOREST FERTILIZATION. *A bibliography, with abstracts, on the use of fertilizers and soil amendments in forestry. World Forestry Ser. Bull. No. 2.*

Compiled by Ronald P. White and Albert L. Leaf. State University College of Forestry, Syracuse. $3.00. 303 pp. 1957.

Outside the forest-tree nursery, fertilization of forest trees is as yet practiced on an exceedingly small scale. But the prospect of increasing the growth of forests by the use of fertilizers is by no means a new idea in silvicultural circles. Increasing interest in forest-tree physiology and genetics in recent years has given additional impetus to such research, and it is appropriate and timely that *Forest Fertilization* should be published. The book is a bibliography, with abstracts in English, on the use of fertilizers and soil amendments in forestry. Preference has been given, wherever possible, to the use of author-prepared abstracts.

The principal objective was to report investigations on the use of fertilizers in natural stands or plantations of forest trees. Included also are references to research investigations on the use of fertilizers in forest nurseries, shade tree and landscape practices, and nutritional studies of forest trees in greenhouse, pot culture, and hydroponics experiments.

One obvious shortcoming of this bibliography is the absence of a detailed index, but the partial index appended will doubtless suffice for general reference purposes.

SCOTT S. PAULEY

GENERAL AND SYSTEMATIC ZOOLOGY

ATLAS OF INVERTEBRATES OF THE FAR EASTERN SEAS OF THE USSR.

Edited by P. V. Ushakov. Zdatel 'stvo Akademia Nauk, Moscow-Leningrad. 40 rubles 10 kopeks. 244 pp. + 67 pl. + 2 colored charts. 1955.

This is a compilation by various specialists. To each group is appended a brief bibliography, usually well up to date. While the emphasis is on common and conspicuous animals, such groups as the Foraminifera and Cumacea are included. When known, information on depth, temperature, salinity, and geographical distribution is provided. The plates (gathered at the end of the book) are for the most part copied from standard monographs, but they have been well arranged and pleasingly reproduced by offset. There has been an obvious effort to make this atlas a good printing job. The format is a double-column quarto, which shows off the Cyrillic type to good advantage and also makes it easier to read. The type face is somewhat different than the usual book face, with some pleasing differences, although the long recurved tails of certain letters are a bit fussy. The color frontispiece, of *Patiria pectinifera*, is excellent. It is interesting to note that the book has been reproduced by offset.

There is much useful information in this "atlas" for marine zoologists on the American side of the Pacific Ocean, but we hesitate to predict how many years it may be before a similar American atlas can be prepared, let alone find an enlightened publisher.

JOEL W. HEDGPETH

LEHRBUCH DER SPEZIELLEN ZOOLOGIE. *Teil I: Wirbellose. 2. Lieferung.*

By Alfred Kaestner. Gustav Fischer Verlag, Jena. DM 11.30 (paper). vi + pp. 221–483; ill. 1955.

This is an installment of a treatise on taxonomic zoology. The part considered here is devoted to the "Spiralier," a superphylum characterized by spiral cleavage of the embryo and consisting chiefly of the Mollusca and the Annelida. It is surprising, however, that the author has united with these the Onycophora and the Tardigrada, usually considered to be arthropods, and the *linguatulids*, a group of uncertain systematic position.

Kaestner's most original contribution, in this work, is a detailed discussion of the embryology of the different kinds of Mollusca. The many illustrations, dispersed throughout the text, are far superior to those of average works. Illustrations of the torsion of the pallial complex of the Gastropoda are particularly good.

No radical changes in taxonomy have been brought about by the author's emphasis on embryology. The only striking departures from classical practice are a transfer of the Paleozoic *Tryblidium* to the Polyplacophora, the assignment of the Unionidae to the Eulamellibranchiata, and erection of a new order for the bellerophontids. The possibility of a relationship between the cephalopods and the scaphopods is suggested with due restraint.

The usefulness of this work would be increased by the addition of a general index and by a more restrained use of abbreviations in the bibliographies, which are quite full. Despite these minor shortcomings, an English translation would be a most welcome addition to any library.

JOSHUA L. BAILY, JR.

A HISTORICAL REVIEW OF THE MOLLUSKS OF LINNAEUS, *Part 5. The Genus Murex of the Class Gastropoda. Bull. Amer. Mus. nat. Hist., Vol. 113, Art 2.*

By Henry Dodge. American Museum of Natural History, New York. $2.50 (paper). pp. 73–224. 1957.

The shells of the genus *Murex* are commonly called Rock-Shells not because they live in the rocks, although many of them do, but because they look like rocks. Yet in the Linnaean genus there are some species, such as the well-known *Fasciolaria tulipa* L., whose graceful symmetry and delicate coloration are more suggestive of a modern work of abstract art than of a piece of stone shaped by fortuitous circumstances.

In the years that have followed the publication of the twelfth edition of the *Systema Naturae* most of the Linnaean species have been divided up into new ones, and many of these in turn have been made the types of new genera. Perhaps no Linnaean genus offers a better demonstration of this tendency than *Murex*. The genus *Bulla* has been more widely dispersed through the various orders and suborders of the Gastropoda, but *Bulla* is a relatively small genus. On the other hand, *Murex* originally contained probably more species than any other molluscan genus of Linnaeus, but today these are all confined to the suborder Monotocardia.

Since so many of the species of *Murex* have subsequently become types of new genera, the importance of a clear understanding of the Linnaean names is manifest. Probably no single volume in the present series will be found more helpful, although all of them are important, and the author has earned the gratitude of all systematic malacologists by his labors. It must be remembered, however, that this work is based mostly on an examination of the literature, and that the author's knowledge of the material in the Linnaean collections has been derived largely from second-hand sources. This, of course, is inevitable, and it is no disparagement to the author to notice that a minute examination of the material in the University of Uppsala or the Linnaean Society of London might conceivably throw additional light on some of the problems which the author has had to face.

Perhaps the most interesting of the Linnaean species of *Murex* is that known today as *Busycon perversum*. This name has been used indiscriminately for three rather distinct species, on the assumption that since they occur in both dextral and sinistral forms, they must be the same. Unfortunately, the most plentiful of these, which is consequently the one to which the name has most frequently been applied, is not the one to which it belongs under a strict application of the rules. It would have been well if the student who first became aware of this condition had immediately made application to the International Commission on Zoological Nomenclature for suspension of the rules in order to preserve a thoroughly established usage. Probably a proposal for such action at this late date would not meet with a very enthusiastic response. Consequently the term *perversum* must now be used for the form formerly known as *kieneri*, while the form which by almost universal tradition has been known as *perversum* must be called *contrarium*. This is unfortunate, inasmuch as the type of *contrarium* is a fossil which differs rather conspicuously from its descendent in the Holocene. The literature should be searched to see if any of the varietal names which have been applied to this species might not be more appropriate.

At the northern end of the range of *Busycon perversum*, in Florida, the sinistral form predominates; in Texas the two are approximately of equal frequency; in Yucatan only the dextral form is found. The ratio between the frequencies changes with fair regularity throughout the extent of the range; thus the populations constitute a cline. If these two forms derive from a pair of Mendelian alleles, one would expect occasionally to find strings of nidamental capsules in which the two forms would occur in a proportion which could be interpreted as a Mendelian ratio, but personally I

have never encountered a string containing a mixed brood, nor have I heard of any other investigator who has done so. Within each nidamental string all the embryos are coiled in the same direction.

Of course the possibility that matroclinal inheritance is involved must not be overlooked. In such a case the genetic character would be, not the direction in which the shell of the propositus is coiled, but that assumed by the first filial generation. In such case, an individual might be genotypically dextral but phenotypically sinistral, or vice versa. Such a condition has occasionally been observed in other gastropods, but never in *Busycon*. Should it occur, it could readily be detected without the necessity of breeding *Busycon* in captivity, for the nidamental strings of capsules in this genus are coiled in a helix whose direction agrees with that of the shell of the parental snail. If the direction of coil is matroclinally determined one would expect occasionally to find a dextrally coiled nidamental string containing sinistrally coiled embryos, but again I have never seen nor heard of such. However, they may exist, and specialists in *Busycon* should be advised to be on the lookout for strings containing heterostrophically coiled embryos. I am personally inclined to think that the dextral and sinistral shells are not conspecific, but represent two distinct species, in which case the non-occurrence of nidamental strings containing heterostrophic embryos need occasion no surprise.

The third reversed *Busycon* is found along the shores of New Jersey, Delaware, and Maryland. It was apparently not known to Linnaeus—so far as I am aware, it has never been given a name. I have never seen a living specimen, and it may be already extinct, but dead shells are not rare on the beach, especially after storms. In appearance it resembles *Busycon carica* more closely than it does the sinistral species from further south. Could this form be the mysteriours *Bucinum ampullatum* of Lister?

Outside this genus the species *Neptunea antiqua* L. *Neptunea contraria* L., and *Turbinella pyrum* L. also occur in both dextral and sinistral forms. Linnaeus included the first two of these in *Murex* and the last in *Voluta*. It is conceivable that an examination of the nidamental masses might throw light upon the relationship of the dextral and sinistral forms, but I have never seen their nidamental masses myself.

This treatise on the Linnaean *Murex* is a worthy companion to the earlier instalments of the series, and in my own opinion the most interesting that has so far appeared, owing to the fact that the treatment given the group by Linnaeus has opened the way to so many new problems.

JOSHUA L. BAILY, JR.

FRESHWATER MOLLUSKS OF ALABAMA, GEORGIA, AND FLORIDA FROM THE ESCAMBIA TO THE SUWANNEE RIVER. *Bull. Florida State Mus., biol. Sci. Vol. I, No. 3.*

By William J. Clench and Ruth D. Turner. Florida State Museum, Gainesville. $1.80 (paper). Pp. 97–239 + 9 pl. 1956.

This work results from several collecting trips made by the senior author in recent years. Since the literature of more than a century has been checked to verify early locality records, the reader has every reason to expect completeness. The work is not a historical index of past records, however, so much as a report of what is actually living today in the area surveyed. Extensive commercialization of the water resources in the southeastern states is rapidly destroying many native fauna. Their obsolescence is reflected in the poverty of the fauna covered by this report.

Alabama's freshwater mollusk population, larger than that of any other state, consists primarily of the families Unionidae and Pleuroceratidae. Eighty per cent of the species reported by Clench and Turner belong to these two families, which are largely confined to the area east of the Mississippi. The Basommatophora, of worldwide distribution and generally the most abundant in species and in individuals in those areas within which they occur at all, are practically absent from the southeastern states. The Ancylidae and Lymnaeidae are represented by a single species each; the Physidae by only two; and the Planorbidae, generally the most plentiful elsewhere, by none at all. This is the more surprising in view of the remarkable forms that represent the Planorbidae east of the Suwannee River and west of the Escambia.

This booklet illustrates very well the importance of making collections of freshwater mollusks throughout the United States, especially in the southeastern part, before it is too late. Already it is later than we think. That remarkable gastropod *Tubatoma*, formerly abundant in the upper reaches of the Coosa river, has already joined the passenger pigeon and the heath hen, as another victim of the greed of mankind.

The use of this important and well-executed work would be facilitated by the addition of a general index.

JOSHUA L. BAILY, JR.

CATALOGUE COMMENTÉ DES COLÉOPTÈRES DU MAROC. *Fasc. IV. Clavicornes et groupes voisins. V. Hétéromères (Ténébrionides exceptés). Trav. Inst. sci. Chérif., Sér. Zool., No. 11 and 10.*

By Louis Kocher. Société des sciences naturelles et physiques du Maroc, Rabat. (IV) 500 fr. (paper); (V) 400 fr. (paper). (IV) 138 pp; (V) 107 pp. 1956.

Two lists of beetles found in Morocco, with specific localities and critical comments.

CHECK LIST OF THE REPTILES AND AMPHIBIANS OF EAST AFRICA (UGANDA; KENYA; TANGANYIKA; ZANZIBAR). *Bull. Mus. comp. Zool. Harv., Vol. 117, No. 2.*

By Arthur Loveridge. Museum of Comparative Zoology, Cambridge. $2.50. Pp. 153–398. 1957.

This is a meticulously compiled checklist of 527 forms recognized as occurring in the area. The herpetofauna is rich, with 7.8 forms per 10,000 square miles as compared with 1.1 in the United States and Canada. Loveridge recognizes 15 forms of turtles, 3 crocodilians, 179 lizards, 161 snakes, 9 caecilians, and 160 frogs and toads. There are no salamanders. In addition to the preferred citations, the author provides an exhaustive list of synonyms with taxonomic interpretations in the form of footnotes. There is also an annotated bibliography and a 36-page index of scientific names. This *Check List* will be an indispensable reference for those planning serious herpetological studies in East Africa and nearby areas.

ARNOLD B. GROBMAN

ECONOMIC ZOOLOGY

THE PIGEON. *Second Edition.*

By Wendell Mitchell Levi; preface by Oscar Riddle. Levi Publishing Company, Sumter. $20.00. xxviii + 667 pp. + 3 pl.; text ill. 1957.

The many persons in this and other countries who raise or enjoy pigeons for any of the various reasons which may be given for their interest—as pets, as a means of livelihood, or as experimental animals—will look on this revised edition of a highly successful book as the most complete source of information in existence on this interesting bird. The book begins with an account of the archeological records of the close association of pigeons with man, their early use for sacrificial purposes and also as objects of religious veneration, to their importance for centuries as carriers of messages in wars. The great variety in morphological appearance of breeds in different parts of the world is described in detail and well illustrated by representative photographs.

Detailed descriptions of various aspects of the raising of pigeons are given, such as their behavior, the various diseases and parasites which are common in pigeons and the known methods of treatment and control, their housing needs, and feeding. It is unfortunate that precise knowledge of the nutritive requirements of the pigeon is not available.

Apart from the descriptive anatomy of the pigeon, its use as an experimental animal has been primarily in the study of their physiology (endocrinology) and genetics. The sections dealing with these studies are well written and informative.

The author gracefully acknowledges the assistance given by many persons in his task of gathering the material for the book. The extent of the task is indicated in part by the length of the bibliography, which covers approximately 25 pages. It may safely be predicted that this edition will definitely exceed the previous one in its appeal to fanciers, producers, naturalists, and other specialists.

M. R. IRWIN

THE DEER OF NORTH AMERICA. *The White-tailed, Mule and Black-tailed Deer, Genus ODOCOILEUS. Their History and Management.*

Edited by Walter P. Taylor; color plates by Walter A. Weber; drawings by Wallace Hughes. The Stackpole Company, Harrisburg, and the Wildlife Management Institute, Washington, D.C. $12.50. xx + 668 pp. + 39 pl.; text ill. 1956.

Encyclopedic is the only word that aptly describes this monumental work on North American deer. The authors are all authorities in their particular fields, and this compilation contains the most complete and detailed accounts of all aspects of the life, ecology, and chase of these, the most important species of American big game. Whether one is a scientist interested in classification of deer, a game manager interested in maintaining healthy shootable populations, an ecologist interested in the relationships of deer to their environment, or a sportsman in search of tips on successful deer hunting, this book has the answers.

The book is divided into three portions. The first and most extensive portion, comprising about half of the total number of pages, is devoted to the white-tailed deer. The remainder is divided between the mule deer and its western cousin, the blacktail. Each section opens with a chapter on the taxonomy of the species. The mule deer and blacktailed deer are combined into a single chapter, as being taxonomically only subspecifically distinct from one another, although their habits and ecological relationships are sufficiently unlike to warrant fully the separate treatment which follows.

It is obvious that each author was allowed considerable autonomy in developing the subject matter of his particular section. This has resulted in a refreshing variety of style in the treatment of a subject that might otherwise have become unduly repetitious. Naturally the life histories and ecology of such closely related animals will have many points in common, yet for each to be treated fully, the same material must be covered for both. It is a credit to the editor that much useless repetition has been avoided. Another commendable feature is the degree to which raw data have been compiled, digested, and converted into a meaningful whole. The authors have not stopped with a mere presentation of facts, but these facts have been woven into a coherent story. Yet, because of the copious cross-references to the original sources of information, the reader is not lost if he wishes to pursue further his investigation in any particular line of study. The literature citations alone cover 33 pages of closely spaced type.

One cannot omit mention of the two beautiful color plates and the drawings that head each chapter, nor the numerous photographs which present so many details far better than words.

BRYAN P. GLASS

LIVESTOCK IMPROVEMENT *in Relation to Heredity and Environment. Fourth Edition.*

By J. E. Nichols. Oliver & Boyd, Edinburgh and London. 16s. xii + 240 pp. + 7 pl.; ill. 1957.

The 4th edition does not differ materially from the 3rd, published in 1943, since the author is writing for the beginning student in livestock breeding and the practical livestock breeder and rancher. Chromosomes, genes, fertilization, and Mendelian principles are treated in a 12-page chapter, and topics such as mutation, multiple allelomorphs, modifying genes, and gene frequency are discussed and illustrated by examples involving farm animals in 3 equally brief chapters. The remainder of the book considers the practical problems in animal breeding and contains information of the type which has real value to professional livestock breeders. The role of the environment in the evolution of types and breeds of livestock, and the importance of environmental factors in current selection in different parts of the world is particularly well covered, and should be of interest to physiologists, nutritionists, and economists.

FREDERICK N. ANDREWS

ADVANCES IN VETERINARY SCIENCE. *Volume III. Edited by C. A. Brandly and E. L. Jungherr. Academic Press, New York.* $13.00. xii + 579 pp.; ill. 1957.

The third volume of this series follows the policy established for the first two—that of summarizing generally accepted facts in specialized areas and of presenting the theories of outstanding veterinary scientists from various parts of the world. This volume includes a concise summary of the characteristics of nearly all the drugs which are used by veterinarians in premedication, narcosis, relaxation, shock, and replacement therapy and the use of antidotes in anesthesia, written by L. W. Hall of Cambridge, England. Innes and Saunders have accomplished an exceptionally complete and informative review of present knowledge of the diseases of the central nervous system of domesticated animals and have made pertinent comparisons with human neuropathology. The inclusion of more than 600 references provides medical scientists with an invaluable source of information on common and obscure diseases involving the nervous system. Brucellosis, a disease of man, cattle, swine, goats, and sheep, has been dealt with in 3 chapters. Thompsen of Copenhagen, gives an excellent account of the history of brucellosis in the Scandinavian countries and the techniques which have been employed in its diagnosis and eradication. Renoux, of the Pasteur Institute in Tunis, has summarized the history of brucellosis in the Mediterranean area, where it has long been a problem in man (Malta fever) and in sheep and goats which are raised in large numbers for milk and meat. Cameron of the University of California completes the brucellosis picture with an almost too brief summary of the present status of the diagnosis and control of the disease in swine. There are two excellent chapters on veterinary parisitology. H. M. Gordon of Glebe, Australia, has discussed the helminthic diseases of domestic animals. While his presentation has been written primarily for the clinical parasitologist, its summary of information is worldwide in scope and will make it useful to all research workers dealing with the helminthoses. L. M. Jones of Iowa State College has, in a highly systematic and concise fashion, described the chemistry, metabolism, toxicity, and effective use of antinematodal drugs including piperazine, sodium fluoride, cadmium salts, toluene, phthalofyne, chlorinated hydrocarbons, and many others. Clostridial diseases of domestic animals, among them blackleg, botulism, and tetanus, have been authoritatively discussed by L. D. Smith of the Montana State College. The artificial insemination of cattle has become widely used throughout the world because of its value in livestock improvement through the application of genetic principles. Vandeplassche of Ghent has discussed the subject with particular reference to the problems of genital diseases and fertility. His chapter will prove to be a good source of reference material to European and American work.

Teachers and veterinary research workers will find this third volume as essential as the first two.

FREDERICK N. ANDREWS

RESEARCH ON GUIDING YOUNG SALMON AT TWO BRITISH COLUMBIA FIELD STATIONS. *Bull. 117.*

By J. R. Brett and D. F. Alderdice. Fisheries Research Board of Canada, Ottawa. 75 cents (paper). viii + 75 pp.; ill. 1958.

ANIMAL GROWTH AND DEVELOPMENT

INTRODUCTION TO GENERAL EMBRYOLOGY.

By A. M. Dalcq. Oxford University Press, New York. $6.50. vii + 177 pp.; ill. 1957.

This little book is a refreshing departure from today's trend toward publications in embryology and genetics which appear to have been stamped from the same die. It is a distinctive attempt at a synthesis of the facts and ideas of general embryology. First, tribute is due the translator, Jean Medawar, who has submerged her own identity so effectively that the reader, especially one already familiar with Professor Dalcq's style, knows that he is reading Dalcq, and not an abridgement or an imitation. An impeccable translation is of prime importance, for the book is in many ways a highly personalized account of the author's views on the field of embryology, its past, present, and future. Perhaps

some readers will object to Dalcq's individualism, especially his insistence on terminology which has not gained a wide acceptance. Were the book designed for use as a textbook in the usual sense, such a criticism might be valid. It is not to be viewed as a conventional textbook, however, but as a collection of essays, well integrated, bringing together embryology, cytology, genetics, and a dash of biochemistry as seen through the eyes of one individual. It is a selective account; the examples chosen often are off the beaten track, usually to good advantage. This *Introduction to General Embryology* is, indeed, introductory in the factual sense; it assumes little background in embryology on the part of the reader. On the other hand, it is far from elementary philosophically. It records vividly Dalcq's views on such subjects as the history of embryology, organism and individuality, development and heredity, and, especially, development and evolution. Not all of his readers will agree with the author's views in the latter domain. For example, Dalcq finds it almost impossible to see how the origin of the Metazoa and the appearance of new types of germinal organization can be based on the "mutation-selection theory." He believes that there is something more in the evolution of biological systems than mutation and selection—the "ontomutation"—the simultaneous mutation of a chain of developmental events.

The book has had an interesting history. It grew out of a series of radio broadcasts delivered by the author in 1951. A French edition was published in 1952, and enjoyed considerable acclaim. For this English edition most of the chapters have been revised extensively, a new chapter on mammals being added.

In summary, this volume is a valuable addition to the biological literature. I would object only to the title, which does not fully portray this little work. Perhaps a subtitle is in order, like "Reflections of an Embryologist."

JAMES D. EBERT

BEGINNINGS OF EMBRYONIC DEVELOPMENT. *Symposium held December 27, 1955 at the Second Atlanta Meeting of the AAAS.*

Edited by A. Tyler, R. C. von Borstel, and C. B. Metz. The American Association for the Advancement of Science, Washington. $8.75 (AAAS members, $7.50). viii + 400 pp.; ill. 1957.

On December 27, 1955, a Symposium on the Formation and Early Development of the Embryo was held at the annual meeting of the American Association for the Advancement of Science. Almost two years later the Association has published in this volume the papers presented at the symposium, supplemented by additional articles contributed chiefly by investigators from outside the United States. Except for clues given by the country of origin, one cannot distinguish the supplemental articles from those presented at the symposium, for the discussions following the latter papers are not included. Although the editors state that they made no attempt to develop an over-all concept or plan for the symposium, it does possess a degree of unity often lacking even in books in which unity has been an avowed goal. One paper deals with the development of the oocyte, five with egg activation, and the remaining seven with early development, emphasizing nucleocytoplasmic relations and the description of development in chemical terms, e.g., enzymologic and immunologic studies. The delay in publication has not detracted from the usefulness of the book, a matter reflecting not only skill on the part of the authors and editors in keeping manuscripts up-to-date during the lag period, but regrettably, also, the fact that few major advances have been reported in the field recently which would be conspicuous by their absence. Although it is difficult to generalize about a book containing the ideas of 15 contributors, the following remarks seem warranted. There is little to differentiate this book from numerous other treatments of the same and related subjects published within the past five years. It does not stand out as unusually strong or weak. Collectively, the articles can be said to be comprehensive, unprejudiced accounts of recent work. As a group, the papers have extensive bibliographies; little has been omitted. Inclusiveness is an easy virtue to achieve, however; critical selection is a more difficult goal, attained by only a few of the contributors. In this category I would place the following: Morphology of Fertilization: Acrosome Filament Formation and Sperm Entry (A. L. and L. H. Colwin); Morphogenesis and Metabolism of Gastrula—Arrested Embryos in the Hybrid *Rana pipiens* ♀ × *Rana sylvatica* ♂ (John R. Gregg); Nucleocytoplasmic Relations in Early Insect Development (R. C. von Borstel); and Some Studies on Differentiation and Development of the Oocyte (W. S. Vincent). Among the more general review articles, those by C. R. Austin and M. W. H. Bishop, and Albert Tyler proved personally to be especially useful. Other contributors include Charles B. Metz, M. C. Chang, Alberto Monroy, H. E. Lehman, John R. Shaver, Silvio Ranzi, and G. Reverberi. The book is well illustrated (especially the article by the Colwins). The index is adequate.

JAMES D. EBERT

HORMONES AND THE AGING PROCESS. *Proceedings of a Conference held at Arden House, Harriman, New York, 1955.*

Edited by Earl T. Engle and Gregory Pincus. Academic Press, New York. $8.50. xii + 323 pp.; ill. 1956.

This volume is disappointing—its contents have little to do with its title. The chapters dealing with hormones have only an occasional relation to aging, and those that

treat aging are not too obviously correlated with hormones. For readers who might expect to gain some insight into the basic nature of the Aging Process(es?), this book cannot help but be a disappointment. For those who are content to peruse some high-entropy thoughts in an attractively bound volume, it may be useful.

Much of this book is devoted to various medical and physiological effects of steroid hormones. Some of the papers are thought-provoking even though they give little insight into the nature of aging. Others, particularly the papers entitled Sex Steroid Replacement in the Aging Individual, by Wm. H. Masters, and Effects of Steroids in Women with Breast Cancer, by B. J. Kennedy, seem so clinically oriented and so far removed from scientific aspects of the aging process that the basis of their inclusion in this volume is somewhat puzzling.

The paper by Pincus on age decrements in the urinary excretion of various steroids is interesting, and perhaps wisely, not given to an extensive interpretative or hypothetical treatment. One wonders why the author sometimes finds it convenient to use linear plots and at other times semi-log plots, and to what extent the differences in excretory rate reflect renal changes rather than a change in the potential for production of these hormones.

Ingle's short report and dissertation on pathology and stress in rats is stimulating, and so too are some of the other shorter papers. Yet, by and large, this volume is not in my opinion necessary to the biologist interested in senescence as a biological phenomenon. In many respects such books do more harm than good, both because of the distress they bring to those who would prefer to see gerontology develop as an orderly and respectable science and because they add to the already extensive literature low in information-content in the field.

The classified bibliography on aging, compiled by Nathan Shock, now contains more than 15,000 papers. Presumably one can, with sufficient time and effort, separate the wheat from the chaff in that enormous multidisciplinary bibliography. The present volume does little to help. Perhaps a quotation from Comfort's *Biology of Senescence* has some relevance here: "Much modern research into aging tends to be desultory, although the single subjects with which it deals are important in themselves. We ought to try to devise critical experiments, and if we destroy more hypotheses than we demonstrate, this is a subject which can well stand such treatment in contrast to the speculation which has gone before."

BERNARD L. STREHLER

ANIMAL MORPHOLOGY

AN ATLAS OF FETAL AND NEONATAL HISTOLOGY. *By Marie A. Valdés-Dapena; foreword by Edith L. Potter. J. B. Lippincott Company, Philadelphia and Montreal.* $11.00. ix + 200 pp.; ill. 1957.

In the past decade there has been a resurgence of interest in the subject of human reproductive wastage. This includes ectopic pregnancy, abortion, and fetal and neonatal deaths, as well as the sequelae of insults during the pregnancy period such as cerebral palsy, mental retardation, behavior disorders, and epilepsy. For example, in obstetrics the reduction of maternal mortality has transferred the interest of clinicians into evaluating the causes of fetal and neonatal death. This has placed great demands on the pathologist who performs autopsies on fetuses and newborn infants. Valdés has written a useful atlas which fills a need in those gaps between treatises on embryology and a majority of present-day pathology textbooks. This atlas includes approximately 238 photomicrographs of various stages of development in the fetal and neonatal tissues. Specific details on the blood vessels, heart, lung, spleen, kidney, liver, gastrointestinal tract, genitalia, pancreas, adrenal, thyroid, thymus, and a group of miscellaneous organs are illustrated. At the end of each chapter a selected bibliography on each topic is presented.

The case data for each one of the illustrations, including the weight in grams, measurements in centimeters, gestational age of each fetus, and a useful table of normal values, correlating the relationship of age and lengths of the fetus in comparison to weight, complete this interesting atlas. The purpose of the author has been to outline histologically the development of each of the major organs of fetuses weighing as little as 150 grams and ending with a child of 3½ years of age. The descriptive legends are excellent, and the text is in clear precise style.

The Foreword is written by Edith L. Potter, distinguished fetal pathologist, who endorses the book as being of great value to persons working in pathology who find it necessary to interpret microscopic sections.

GEORGE W. ANDERSON

ANIMAL PHYSIOLOGY

INSECT FLIGHT. *Cambridge Monographs in Experimental Biology, No. 9. By J. W. S. Pringle. Cambridge University Press, New York and London.* $3.00. vii + 132 pp. + 4 tables; ill. 1957.

Even before man himself was able to fly, the phenomenon of flight captured his imagination. He studied the mechanisms of flying in all airborne organisms from insects to bats. The small size of insects and the speed of their wing movement made study extremely difficult prior to the introduction of photographic and other instrumental aids. Until very recently all of our knowledge of insect flight was derived from Magnan's *Le*

Vol des Insectes (1934). In the two decades which followed, other investigators applied to this problem the methods of modern biology with such gratifying success that our knowledge of insect flight was greatly increased. Since 1953, when the last review of the subject appeared (L. E. Chadwick in K. D. Roeder's *Insect Physiology*), progress has continued at a pace which more than justifies a new review. There is no one better qualified to undertake this than Pringle because of his own contributions to the field.

In the present volume he has presented a critical, detailed, and readable account of the present status of insect flight. A concise account of the general anatomy of the wings and of a wing-bearing segment is followed by a discussion of the form and mechanism of wing beat, and this in turn by an account of the histology, biochemistry, and physiology of flight muscle. The remainder of the book is devoted to aerodynamics and to nervous and sensory mechanisms concerned with flying. The illustrations match the text in clarity, and the excellent bibliography is complete to 1957. Altogether this is an excellent monograph.

V. G. DETHIER

BODY WATER IN MAN. *The Acquisition and Maintenance of the Body Fluids.*

By Maurice B. Strauss. Little, Brown & Company, Boston and Toronto. $7.00. xix + 286 pp.; ill. 1957.

This is a well-written, relatively brief account of the current status of work on the regulation of the volume of the body fluids. Concerned with basic physiology, it can be recommended as useful orientation reading for medical students and others who desire some background in a fairly active field. Written with a light touch and highly readable, it presents well-chosen material on thirst and appetite, the physiological control of the renal excretion of water and salt, aldosterone, and current studies on the role of changes in the volume of the body fluids in determining the renal excretion of sodium. In contrast to Elkinton and Danowski's 1955 treatment of the body fluids, it includes no therapeutic minutiae, and is considerably shorter.

EVELYN HOWARD

THE ELECTROPHYSIOLOGY OF THE HEART. *Ann. N. Y. Acad. Sci., Vol. 65, Art. 6.*

Editor-in-chief: Otto v. St. Whitelock; 44 contributors. The New York Academy of Sciences, New York. $4.50 (paper). Pp. 653–1145 + 1 pl.; text ill. 1957.

Conferences such as the one which produced this monograph have become increasingly frequent. They are often very poor and may leave the non-specialist more confused than instructed. The report of this conference, on the contrary, is the very model of the form at its best. The participants, with few exceptions, have at least touched upon the bases and definitions of their work before elaborating its esoteric features. In many instances the content was new when presented and where this was not so, older material was usually summarized clearly. The discussion as reported has been held to a tolerable level and occupies only a small fraction of the total text. Unfortunately a period of eighteen months (February, 1956, to August, 1957) elapsed between the time of the conference and the publication of its report. This is a serious fault which partially offsets the other merits of the volume, although specific topics have been treated more extensively in other places. Nevertheless, this monograph becomes the best available source for the general topic of the electrophysiology of the heart. A pleasing feature of the book is the appropriately varied nationality of its authors.

Interest in this field has been growing rapidly during the past ten years. Symptomatic of such interest are the occupations of contributors to the first part of the monograph. As C. E. Kossmann has noted, this section, Cellular Events During the Cardiac Cycle, included as participants an axonologist, an electrophysiologist, a physical chemist, a physiologist, a clinical investigator, and finally a clinician. It is probably the area covered by this first section which is developing most rapidly, and the presented material serves as a good background for the appreciation of current investigations into the nature of pacemaker activity.

There are four other sections to the monograph. The second deals with the spread of the impulse through cardiac muscle and includes an excellent panel discussion on anomalous atrioventricular excitation. The last is much benefited by a summary from its editor, Hans Hecht. The next section is concerned primarily with the electrical features of cardiac recovery. The fourth section describes concepts in the distribution of electrical potentials in volume conductors, and the final section an analysis of the surface vectorcardiogram.

SAMUEL H. BOYER

HÉMOSTASE SPONTANÉE, PLAQUETTES SANGUINES ET PAROIS VASCULAIRES. *Ier Symposium de la Fondation Valentino Baldacci.*

Omnia Medica Éditeur, Pisa. L. 2500 (paper). 190 pp. + 2 pl.; text ill. 1956.

This symposium discusses the problem of spontaneous hemostasis. The role of platelets and vascular endothelium in bringing about this phenomenon is emphasized. The first part is devoted to the projection of a movie which shows the morphological aspect of normal platelets and the alteration they exhibit during and after traumatic injury or local anaphylactoid reaction in mesenteric vessels of the rabbit. The rest of the symposium is an informal but quite stimulating debate on

platelet agglutination, adhesion to vessel walls, and the alteration of the vascular wall after traumatic injury. Finally, fibrin formation and its retraction are discussed, as well as two other problems worth mentioning. One is the role of vascular vasomotor response to injury in spontaneous hemostasis. The other, with an important clinical aspect, is the use of platelet transfusion for the prevention of hemorrhage due to thrombocytopenia.

N. T. SHAHIDI

PRINCIPLES OF IMMUNOLOGY.

By John E. Cushing and Dan H. Campbell. McGraw-Hill Book Company, New York, Toronto, and London. $6.50. ix + 344 pp.; ill. 1957.

This textbook should prove a welcome source of information and stimulation to advanced undergraduate students and graduate students in the biological sciences. It is an excellent introduction to immunology for those who are interested in a clear, well-written presentation of the basic concepts in the field and the many fascinating areas of study encompassed by the term "immunological investigation."

Relatively little medical immunology is included as such, but material is considered when it bears on a particular point under consideration. A wise choice of reference material is included, emphasis being placed on review articles and selected original papers rather than on an attempt to present an "up-to-the-minute" bibliography.

The authors have not intended this book as a laboratory guide, but there are certainly numerous parts of the text which could admirably serve as a framework for a laboratory course in "biological immunology."

The text is divided into 3 major sections. The first section presents an introductory survey of fundamental principles of immunology, and these ideas are subsequently developed in more detail in the third section. Problems which are considered include some of the basic physical and chemical factors important in studying the immunological response, the nature of antigens and antibodies, manifestations of the immune response, and mechanisms controlling immunological specificity. Section 2 reviews and discusses in an interesting manner many of the research areas in which an immunological approach has contributed significantly to a further understanding of numerous biological problems.

S. R. SUSKIND

ANIMAL NUTRITION

MINERAL NUTRITION AND THE BALANCE OF LIFE.

By Frank A. Gilbert. University of Oklahoma Press, Norman. $5.95. xv + 350 pp. + 23 pl. 1957.

This volume treats the relation of the essential mineral elements to plant, animal and, to a lesser extent, human nutrition. The approach is descriptive. For each element there is a discussion of historical aspects, soil relationships, value to plants and animals, deficiency symptoms, and regions of deficiency. The book is well illustrated and well documented, presenting almost 1200 references with full titles; the coverage is adequate through 1954. It should be noted, however, that biochemical mechanisms and function are not detailed. The text is generally well written but sometimes disjointed because of the description of results of numerous individual research studies. The last 3 chapters of the book, on Enzymes, Hormones and Vitamins, Analytical Methods, and Human Nutrition, are quite superficial.

In summary, this book represents an excellent general compilation in the field of mineral nutrition. It will be useful to the non-specialist who has some interest in these matters, to the beginning student, and to the advanced student of nutrition in conjunction with books of a more metabolic approach.

C. L. COMAR

BIOPHYSICS AND GENERAL PHYSIOLOGY

PHYSICAL METHODS IN PHYSIOLOGY.

By W. T. Catton. Philosophical Library, New York. $10.00. xii + 375 pp. + 10 pl.; text ill. 1957.

This book presents a very good coverage of some of the physical techniques that have been used in physiology. The subjects treated include blood, the circulation, respiration, muscle, nerve, and heat exchange; and there is a short concluding chapter on electronics. Thus interest is directed to cells and cell systems, subcellular studies having been excluded. The emphasis is on methods, although the author usually goes into the relevant theory. Although calculus has been used when necessary to the formulation of the problem, the mathematics used is by and large not burdensome. The bibliography seems fairly complete; however, occasionally the citations in the text seem to be a little sparse. The material is drawn from a wide variety of sources, and the concentration of useful information seems quite high. The sections on mechanical behavior and the energetics of muscle contraction are particularly good examples of the conciseness and clarity with which the author presents material previously known but not too accessible in the original form. It is unfortunate that the author excluded sensory physiology, particularly since this is his own area of investigation. While the book is far from a complete textbook of biophysics, it can be recommended to students of biophysics as a source book for the areas it does cover, as well as to physicists interested in sampling what physiologists have accomplished with physical tools.

Two small criticisms might be directed to the publisher. The price of the book seems rather high; and though the book was apparently completed early in 1955; it was not published until late in 1957.

CHARLES EDWARDS

BIOCHEMISTRY

BIOPHYSICAL CHEMISTRY. *Volume I. Thermodynamics, Electrostatics, and the Biological Significance of the Properties of Matter.*

By John T. Edsall and Jeffries Wyman. Academic Press, New York. $14.00. xv + 699 pp.; ill. 1958.

If one were to select two people to write a book on biophysical chemistry, it would be hard to make a happier choice of authors than the Academic Press has made. Not only have these two scientists done fundamental work on the chemistry of proteins and amino acids, but they have also taught a course on this subject at Harvard for some years. The present book is, in fact, an outgrowth of notes mimeographed for that course. In addition, Edsall coauthored, with the late E. J. Cohen, the well-known work, *Proteins, Amino Acids and Peptides*, which has long been one of the standard references in this field. Though the present volume was not attempted as a revision of that work, it covers and brings up to date much of the same material.

The volume begins with a short chapter on the structure and history of the earth, its crust, and the oceans. There follows a particularly fine chapter on the properties of water and a discussion of the biological significance of these properties. Proteins are the subject of the next chapter; the authors here discuss the properties of amino acids, then the analysis and sequence of amino acids in proteins, and finally current ideas on the helical structures of proteins. A lengthy chapter on basic thermodynamics is followed by chapters on electrostatics, dielectric phenomena, and conductivity. Acid-base equilibrium is discussed, using the Brönsted-Lowry theory, and acidic and basic groups of interest are examined. There follows a chapter on the properties of poly-basic acids, bases, and ampholytes. After a discussion of carbon dioxide, the book closes with a chapter on the measurement and significance of the binding of substances by proteins. A second volume is promised to cover the physical chemistry of macromolecules and of blood.

The discussion of each subject begins with pertinent theory; this is followed by a discussion of examples, usually drawn from areas of biological interest. The intention of the authors was to cover only selected topics in some detail, rather than to survey the entire field. In a book of this sort one wonders about length. Is the chapter, say, on thermodynamics necessary, since there are already so many texts available to cover that field? However, the chapter is written so well that it certainly can stand comparison with most current treatments. In the following chapter electrostatics is treated in detail, but the theory is used as the basis of a comprehensive discussion of ionic interactions and the salting-out effect. Only one chapter is followed by a set of problems; the lack of problems elsewhere is regrettable in a book so likely to be used for teaching. All in all, the authors have succeeded in presenting an enormous amount of material clearly and concisely. The book will obviously become a standard reference work in its field and is highly recommended for use as a textbook for advanced students or for those interested in reading in the area of the physical chemistry of proteins.

The publishers are to be congratulated for getting out this volume so promptly, so that the material dealing with current research is not outdated. However, it must be said that, aside from a normal number of typographical errors, the first sections of the copy read showed the poorest quality of press work I have ever seen in a text.

CHARLES EDWARDS

EXCITED STATES IN CHEMISTRY AND BIOLOGY.

By C. Reid. Academic Press, New York: Butterworths Scientific Publications, London. $7.50. ix + 215 pp.; ill. 1957.

This book, written by an active worker in the field, outlines the physical concepts concerning molecular excitation and reviews the results obtained in complex biological systems. Over two-thirds of the text is devoted to a discussion of quantum mechanics and its application to the excitation processes. A chapter deals with the very important subjects of intermolecular and intramolecular energy exchange and molecular orientation. The remainder of the text is concerned with topics such as phosphorescence of proteins, luminescent reactions in living systems, vision, and the effects of high energy radiation. The status of the investigations into these fields does not yet permit the application of quantum mechanical calculations to explain the observations in these systems. This book should provide the biologist with a bridge to the understanding of quantum mechanics which will one day advance to a stage where it can be applied to biological systems of the type described. The theorist interested in examining these systems will find that this book is an excellent source of stimulating problems. The text should also serve as an introductory primer in quantum mechanics and its application to spectroscopy.

LEOPOLD MAY

ION EXCHANGERS IN ORGANIC AND BIOCHEMISTRY.

Edited by Calvin Calmon and T. R. E. Kressman.

Interscience Publishers, New York. $15.00. xii + 761 pp.; ill. 1957.

This is a well-balanced book on the theory, techniques, and application of ion exchangers in biological and chemical systems. The first part presents general background information on the properties and behavior of ion exchangers. A very valuable second section contains a chapter on the commercial materials available and their characteristics, and also chapters with general descriptions of ion exchange and chromatographic techniques. The major part of the book is concerned with applications in biochemistry, biology, and organic chemistry. While the chapters are variable, they will all be useful for their bibliographies of methods which have been applied successfully in each of 27 areas. Some very interesting chapters deal with the existence and function of ion exchange situations in natural or living systems.

The book is a compendium, with Calmon and Kressman as the editors, so that the opportunity for complete and timely treatment is much increased. It should be a valuable reference work on the technique.

A. T. JAGENDORF

METHODS OF BIOCHEMICAL ANALYSIS. *Volume 5. Edited by David Glick. Interscience Publishers, New York.* $2.50. ix + 502 pp.; ill. 1957.

This is the latest addition to the series which has become an important part of the biochemical literature. Four chapters are devoted to specific analyses: Assay Methods for Cholinesterase (Klas-Bertil Augustinson); α-Keto Acid Determinations (William J. P. Neish); Microdetermination of Cobalt in Biological Materials (Bernard E. Saltzman and Robert G. Keenan); and Chemical Determination of Estrogens in Human Urines (W. S. Bauld and R. M. Greenway). The various analytical schemes for each analysis are critically reviewed, and specific instructions are included for several methods for each analysis. Two chapters are concerned with methods, the equipment for which is not usually found in the average biochemical laboratory. Activation analysis is reviewed by B. A. Loveridge and A. A. Smales. The chapter, The Infrared Analysis of Vitamins, Hormones, and Coenzymes (Harris Rosenkrantz) contains a catalogue of the infrared spectra of these compounds. This will be of greatest value to those who are engaged in the purification and isolation of these compounds. The remaining chapters are concerned with two basic problems in analytical chemistry: standards and contamination. Various biological (virus) and biochemical (enzymes) standards are reviewed by J. H. Humphrey, D. A. Long, and W. L. M. Perry. The section on general principles should be read not only by biochemists but also by others doing research with biological systems. The chapter by Ralph E. Thiers, Contamination in Trace Element Analysis and Its Control, is concerned principally with contamination found in the course of analyzing for trace metals. The many practical suggestions concerning purification of reagents, sampling, and cleaning of apparatus make this summary valuable not only to those measuring trace metals, but also to those investigating biological systems where the control of metal ion concentration is critical. Each chapter contains an ample supply of references to the original literature. This volume continues to maintain the same standards in presentation as its predecessors in the series.

LEOPOLD MAY

BIOCHEMICAL TECHNIQUES. *A Laboratory Manual. By F. M. Strong. Burgess Publishing Company, Minneapolis.* $3.00 (paper). iv + 78 pp.; ill. 1956.

The manual is designed for a graduate course in methods of obtaining pure organic compounds from natural sources, and the analysis of these substances to establish empirical formulae. The author states in the Preface: "No attempt is made to cover methods of animal experimentation, enzymatic procedures, isotopic tracer methods, or the study of proteins and other macromolecules." Thus the title is somewhat misleading, since the text does not cover a large number of biochemical techniques, but rather only the limited area of isolation and characterization of some natural products.

Such basic techniques of organic chemistry as glassblowing, removal of water under reduced pressures, micro-recrystallization, lyophilization, and molecular distillation are covered. These subjects are frequently omitted from laboratory courses in biochemistry, but are invaluable in many biochemical problems. Paper and column chromatographic methods are described, as well as the techniques of molecular distillation, microqualitative detection of elements, and micromolecular weight determinations. The preparation, from natural sources, of glutamine, xylose, trehalose, and fatty acids is also described.

Most sections, commendably, avoid the usual "cookbook" presentation. The selected references in each section serve as a guide to the rather extensive literature of some of these subjects. The manual will be of value primarily to the student embarking in biochemistry, when used with other laboratory manuals which deal primarily with animal and enzymatic methods.

THOMAS M. DEVLIN

THE LIPIDS. *Their Chemistry and Biochemistry. Volume 3: Biochemistry.*

By Harry J. Deuel, Jr. Interscience Publishers, New York and London. $25.00. xxxvi + 1065 pp.; ill. 1957.

The title of the final volume of this trilogy fails to indicate the real scope of the undertaking, since the volume presents a remarkable summary of the lipid literature concerning physiology and nutrition as well as biochemistry. The writing was largely completed before Deuel's death in April, 1956. Acknowledgments of the assistance of several of his colleagues and friends in completing the volume are presented in an introductory note. Also included is a biographical introduction of the author written by George R. Cowgill.

Divided into 14 chapters, the volume begins with a brief chapter summarizing and extending the discussion of the digestion, absorption, transport, and storage of the lipids, which was the major theme of Volume 2. The remaining chapters deal with all biological aspects of fatty acids, glycerides, phospholipids, short-chain and branched-chain acids and their derivatives, cholesterol and related steroids, and the fat-soluble vitamins (A, D, E, and K). It concludes with a detailed discussion of lipids in nutrition. Indexing is by author and by subject, and includes a third section dealing with plant and animal sources of lipids. The entire volume is well documented, the references appearing conveniently as footnotes at the bottom of each page.

An amazing amount of information, much of it far from common knowledge, has been gathered into this book. For the most part, this material has been organized into lucid, easily read lines of argument. The presentation of conflicting theories of historical import is one of the fortes of the book. Detracting somewhat from its usefulness is the subject index, which, though adequate for major topics, is far from complete. Many intriguing bits of information about the less common lipids can be found only by accident or by sifting through a whole chapter on the major class within which they are encompassed.

The time of writing was perhaps a bit unfortunate, in that a great deal of new information on intermediary metabolism, particularly concerning fatty acid oxidation and phospholipid synthesis, is not included. The result is that with respect to intermediary metabolism and enzymology the greatest value of the volume lies in its excellent historical treatment of these subjects. Nevertheless, this book, like its predecessors, will be of great value to any biological reference library.

K. J. Monty

Introduction to Protein Chemistry.

By Sidney W. Fox and Joseph F. Foster. John Wiley & Sons, New York. $9.50. viii + 459 pp.; ill. 1957.

This text was written to "provide an outline of knowledge" of the chemistry of proteins. The discussion proceeds from a consideration of the chemistry, assay, and significance (metabolic and nutritive) of amino acids to the chemistry of peptides, complex components of proteins. The physical properties of proteins are treated in 4 chapters and provide the foundation for discussions on the preparation, purification, structure, and denaturation of proteins. Three chapters are devoted to the chemistry of such specific proteins as blood proteins and hormonal proteins. An introduction to enzymology is included, as well as a consideration of proteins and peptides used as substrates. One chapter provides a brief outline of immunology and contains a glossary of terms used in this field. The origin, evolution, and biosynthesis of proteins are briefly discussed in the final chapter.

The text achieves its aim in serving as an introduction to the study of proteins. It provides a bridge to the understanding of advanced material, references to which are provided at the end of each chapter. These references include books, reviews, and selected original articles. This book should serve well as the basic textbook in a course in introductory protein chemistry if the newer aspects are reviewed in the classroom. It also will provide the non-chemist with a handy reference to the various aspects of protein chemistry.

Leopold May

Advances in Enzymology. *Volume 19.*

Edited by F. F. Nord. Interscience Publishers, New York and London. $9.85. v + 457 pp.; ill. 1957.

The outstanding article in this annual series is undoubtedly Pyrophosphorylases and Phosphorylases in Biosynthetic Reactions, by Arthur Kornberg. The concepts of kinase, phosphorylase, and pyrophosphorylase reactions are generalizations which are able to relate a large number of apparently diverse enzymatic reactions. The full application of these concepts is another step in transforming the jungle of metabolism into a neat, well-ordered park.

Cytochromes in Higher Plants (E. F. Hartree) is full of details concerning the occurrence and activities of cytochromes. This subject will be an even more interesting one to review once the functions of some anomalous cytochromes are more firmly established, especially those located in chloroplasts. Another article dealing exclusively with plants is Reaction Paths in the Respiration of Higher Plants, by W. O. James. While this is not an exhaustive review, it does attempt to organize observations in the field. It is a pleasure to see less emphasis on copper terminal oxidases and more on the cytochromes than in previous reviews by the same author.

In spite of the promise in the title, Desoxyribonucleoprotein, a Genetic Material, J. A. V. Butler and P. F. Davison deal entirely with extraction procedures and chemical properties of the basic proteins associated with

DNA, and have nothing to say of their function in genetics.

Newer Knowledge of Succinic Dehydrogenase, by Thomas P. Singer, Edna B. Kearney, and Vincent Massey, is an admirable review article in which a great deal of information, previously miscellaneous or conflicting, is brought into a coherent framework. It appears as if the groundwork with this enzyme has been accomplished, and further work should really establish a mechanism of action for it as well as place it within the larger framework of an organized mitochondrion.

An interesting summary of a relatively obscure field is found in Lignification, by Walter J. Schubert and F. F. Nord. The Chemistry and Function of Lipoic Acid (Lester J. Reed) is a complete summary of the development of this area by one of the pioneers in the field. Other articles include Mechanism of the Toxicity of the Active Component of *Dichapetalum cymosum* and Related Compounds (the compound is fluoroacetic acid; its primary toxicity occurs after conversion to fluorocitric acid); and Le Role Biosynthetique du Cycle des Acides Tricarboxyliques, by J. M. Wiame (a discussion of Krebs cycle acids as precursors rather than as catalytic components of a cycle).

A. T. JAGENDORF

DIE BIOCHEMIE DER VIREN. *Organische Chemie in Einzeldarstellungen, Band 5.*

By Gerhard Schramm. Springer-Verlag, Berlin, Gottingen, and Heidelberg. DM 36.- (paper). viii + 276 pp.; ill. 1954.

This concise book concerning the biochemistry of the viruses covers its subject matter in clear and well-arranged manner.

The General Part consists of chapters dealing with the classification and nomenclature of viruses, with their biological detection and assay, with methods of isolation, shapes and sizes, electrochemical, chemical, and immunological properties of viruses; and finally with virus-host relationships, mutation, and problems of disease prevention and therapy. The Specific Part contains chapters on (I) Crystalline spheroid plant viruses; (II) Rod shaped plant viruses; (III) Big insect-borne plant viruses; (IV) Bacteriophages; (V) Insect viruses; (VI) and (VII) Near-spherical animal viruses of less, or more than, 50 mμ diameter; (VIII–XII) Various other groups of animal and human viruses.

For its size, the book represents a rather comprehensive survey of most aspects of the viruses, with the general exception only of their pathological, clinical, and epidemiological aspects. The space devoted to bacteriophages is not quite adequate to illustrate the important role they have played in experimental virology, but this can be justified by the existence of other books devoted entirely to bacterial virology.

While reviewed only now, it is a serious drawback that the work appeared 4 years ago. While it is as up-to-date as that circumstance permits, much new information has become available in the interim, so as to make one eagerly await the next edition.

The book is handsomely printed on good paper, contains many clear illustrations, excellent photographs and electron micrographs, and is well indexed. It represents a handy source book for the subject matter which it covers.

H. FRAENKEL-CONRAT

LECTURES IN IMMUNOCHEMISTRY.

By Michael Heidelberger. Academic Press, New York. $4.00. ix + 150 pp.; ill. 1956.

In the preface of this series of 9 lectures, Heidelberger states that "this small volume is an indolent man's response to the urgings of his friends that he write a book." In its own way, this "small volume" is more than the equal of a lengthier text. It is a most enjoyable and stimulating account of many of the high points in the development and application of the quantitative analytical methods which have contributed so greatly toward establishing immunology on firm experimental ground. Six of the lectures were given by Heidelberger in Tokyo in 1955, one in Paris in 1946, one in Marburg in 1954, and the last in New Brunswick, also in 1954. The subjects include general considerations of immunochemistry, its past, present, and future; the chemistry of antigens and antibodies; the development of quantitative analytical methods in immunology, including precipitin and agglutinin reactions; the relation between chemical constitution and immunological specificity; complement and immune hemolysis; immunity and problems of the formation, measurement, and persistence of antibodies in man.

Lectures in Immunochemistry should be appreciated and enjoyed by those who have already embarked on immunological problems as well as those who anticipate doing so.

S. R. SUSKIND

MICROBIOLOGY

ANNUAL REVIEW OF MICROBIOLOGY. *Volume 11. Edited by C. E. Clifton; S. Raffel and R. Y. Stanier, associate editors. Annual Reviews, Palo Alto.* $7.00. vii + 536 pp. 1957.

This volume is a worthwhile addition to the popular *Annual Reviews* series, and should bring research workers interested in microorganisms up to date in a number of diverse areas of current microbial interest.

Noteworthy, in view of the present increased attention being given to Soviet scientific progress, is the review by Grabar covering Soviet microbiological and

immunological investigations in 1956. This volume also includes the following contributions: Finer Morphology of Microorganisms (Fauré-Fremiet); Colicins (Fredericq); Variations in Animal Viruses (Edney); Prediction of Plant Disease Epidemics (Miller and O'Brien); Some Problems in Plant Virus Study (Smith); Soil Microbiology (Thornton and Meiklejohn); Serological Identification of Plant Viruses and Serological Diagnosis of Virus Diseases of Plants (van Slogteren and van Slogteren); Microbial Diseases of Insects (Steinhaus); Oral Microbiology (Hoffman); Non-Genetic Effects of Radiation on Microorganisms (Kimball); Nutrition of Bacteria (Magasanik); Metabolism of Carbohydrates and Related Compounds (Wood); Nitrogen Metabolism (Gale and McQuillen); Acetic Acid Bacteria (Raghavendra Rao); Chemotherapy of Viral and Rickettsial Diseases (Horsfall and Tamm); Antibodies against Enzymes (Cinader); Bacterial Genetics (Cavalli-Sforza); Genetics of the Protozoa (Preer); The Homograft Reaction (Snell); and Use of Tissue Cultures in Virus Research (Ross and Sylverton).

S. R. SUSKIND

YEASTS.

Edited by W. Roman; 7 contributors. W. Junk, The Hague. $7.00. 246 pp. + 4 pl. + 44 tables; text ill. 1957.

In a well-conceived volume, the editor has brought together for the first time a collection of reviews surveying the properties of yeasts and the particular characteristics of those strains of importance to industry. Although there is an index, no attempt has been made otherwise to integrate the material in the individual sections. The vital first chapter on baker's yeast, contains an unimaginative historical introduction and a section by Pyke on culture media, of value only for possible clues to further reading; a section, by Nickerson, further promoting the confused state of yeast cytology; a survey of physiology, by Nickerson and Schultz; and one on industrial production, again by Pyke. Thorne has compiled a well-organized summary on the biology, biochemistry, and technology of brewer's yeast, and brings together the widely scattered literature on these strains. Shorter chapters on wine and fruit yeasts (Schanderl), sake and similar yeasts (Arima), food and fodder yeast (Thaysen), and on yeast preparations (Pyke) serve as introductions to additional yeast strains and their commercial production. No section of the volume includes more than a passing mention of yeast genetics or taxonomy.

References are extensively listed only through 1950 or 1952, with a few additions as late in some cases as 1955. Typographical errors abound in every article.

PHILIP E. HARTMAN

HEALTH AND DISEASE

LES NOUVEAUX SYNDROMES HÉMORRAGIQUES. *La Dysprothrombie. Aspects Actuels—Diagnostic—Traitement.*

By Paul Chevallier and A. Fiehrer. Masson & Cie., Paris. 1,500 fr. (paper). 128 pp.; ill. 1957.

Under the title of dysprothrombinemia, the authors describe briefly the clinical and laboratory data of Serum Prothrombin Conversion Accelerator and Accelerator (Globulin) deficiencies. Although they cover the subject adequately, nothing new is added to the elucidation of these problems. The book is divided into 3 chapters. The first is devoted to the discussion of congenital dysprothrombinemia. The study includes a clinical survey of serum prothrombin conversion accelerator, accelerator (globulin), and prothrombin deficiencies with a comparative table. Some laboratory data, viz., quick prothrombin time and the differential quick prothrombin time, are also mentioned. Finally, treatment according to the type of deficiency is outlined.

The second chapter studies the acquired dysprothrombinemias, and on the basis of etiology is divided into several sections. The first relates to the dysprothrombinemias of hepatic origin, wherein alteration of the usual liver function test expresses the inability of liver cells to elaborate these substances. Regarding the production of serum prothrombin conversion accelerator and prothrombin, the role of vitamin K is emphasized, and conditions in which there is lack of intake (such as hemorrhagic disease of the newborn) or lack of absorption (celiac disease) are discussed. Dysprothrombinemia is also studied in some different hematologic states, such as pernicious anemia, congenital spherocytosis, and leukemia, but no explanations as to mechanism are given. The last part of this chapter is devoted to the study of the action of dicoumarol, heparin, and related substances. The third chapter discusses the diagnostic problems.

N. T. SHAHIDI

THROMBOSES ANTIBIOTHÉRAPIE. MALADIES AVEC AUTOANTICORPS. *Symposiums Techniques et Communications au XXX^e Congrès Français de Médecine (Alger, 1955).*

Masson & Cie., Paris. 2,000 fr. (paper). 284 pp.; ill. 1957.

This Symposium, collecting reports on thrombosis, diseases associated with autoantibodies, and antibiotic therapy, contains some 25 articles preceded by about 30 pages of warm and emotional welcoming speeches. The first contributions deal with thrombogenic diseases. In this connection, R. Fauvert and collaborators discuss cardiovascular conditions in polycythemic patients, and L. Alajouanine and collaborators describe the cerebral accidents in these patients and give some clear

explanations as to the mechanisms of these accidents. The beneficial effect and the preventative role of P^{32} is emphasized in both articles. Continuing the same subject, Edward Benhamou and collaborators report a case of spontaneous thrombosis of the left auricle, but they fail to explain the mechanism involved.

In another paper, G. Cahn and collaborators cite their experiences using hibernation in patients suffering from myocardial infarction. The data taken from clinical and experimental work seem convincing. J. Warter et al. emphasize the frequency of vertigo in patients with coronary thrombosis. In another article, which is also worth mentioning, Vargues and collaborators outline the characteristics and method of extraction of β-lipoglobulin, but no attempt is made to elucidate its relationship with arteriosclerosis and thrombosis.

The second part of the Symposium deals with the problem of diseases associated with autoantibodies. Edward Benhamou reports cases of anemia, thrombocytopenia, and leucopenia, combined or isolated, and having as their etiological factor certain drugs (Para-aminosalicylic acid, quinine) given for therapeutic purposes. In all cases, appropriate agglutination tests placed in evidence either by anti-human-globulin rabbit serum or platelet agglutinin or leucoagglutinin. The leucoagglutinin problem is discussed in two other contributions, by George Marchal et al., and the most logical explanation, the development of isoimmunization after repeated transfusions, is given.

Two other articles show some interesting features: Van Loghem's article on properdin, with a clear description of its characteristic determination and role in hemolysis; and finally the interesting experiment of Jean Bernard and collaborators, in which they produced a Schoelein-Henoch purpura-like syndrome in a guinea pig by intramuscular injection of rabbit anti-guinea-pig endothelium serum.

The third part of the Symposium is devoted to antibiotics and the sensitivity problem. No original work is offered by the contributors. Regarding the problem of resistant organisms, their faith in fortuitous discovery remains the optimistic provision for the future.

N. T. SHAHIDI

DEXTRAN AND ITS USE IN COLLOIDAL INFUSION SOLUTIONS.

By Anders Grönwall. Academic Press, New York. $4.00. 156 pp.; ill. 1957.

During the past 15 years the polysaccharide dextran has been the subject of intensive research directed primarily toward its use as a plasma volume expander in cases of hemorrhage or shock. This work originated in Sweden in 1942 by Grönwall, the author of this book, and his collaborator, Ingelman. The researches were subsequently expanded by cooperation with laboratories in the United States, England, and other countries.

Dextrans are produced from sucrose by growing cultures of the *Leuconostoc* species and of certain other bacteria. They are polymers of D-glucose residues combined chiefly by 1,6-α-linkages. The dextrans synthesized by different species of bacteria vary considerably in their molecular constitution. Thus, the polymer synthesized from *Leuconostoc dextranicum* appears to be essentially unbranched, whereas those obtained by the action of other microorganisms are highly branched. The branches are generally connected by 1,4-linkages, but in some cases linkages of the 1,3-type are found.

In his monograph Grönwall points out that experience from the earlier use of plasma substitutes, such as gum arabic, showed that the chief problem was to find a substance that would produce a colloidal solution possessing properties closely resembling those of plasma proteins without introducing any adverse effects. The substance forming the colloidal solution should contain special physiochemical properties, and a chemical constitution of such a nature as would be degraded and excreted.

The researches carried out by a number of groups which included microbiologists, biochemists, physiologists, and clinicians, led to the practical result that solutions of dextran can now be produced having a satisfactory therapeutic effect, and at the same time avoiding the disadvantages still found in other colloidal infusion solutions. Dextran solutions have now attained considerable clinical use. During World War II large quantities of dextran solution were successfully injected into the blood streams of disabled combat troops. The colloidal infusion solutions have become available in different countries under such commercial names as Macrodex, Gentran, Dextraven, Expandex, etc.

Grönwall's monograph is a comprehensive and timely survey of the literature covering all aspects of research on dextran, and an evaluation of its use as an adjunct to therapy of all types of shock and its resulting acceptance as a plasma volume expander.

W. Z. HASSID

METHODS IN MEDICAL RESEARCH. *Volume 7. Edited by James V. Warren. The Year Book Publishers, Chicago.* $7.50. xiii + 237 pp.; ill. 1958.

James V. Warren of Duke University is the Editor-in-chief of the seventh volume of this useful series. Four areas are covered: (1) chemical investigation of muscle tissues (W.F.N.M. Mommaerts, editor); (2) hemodynamic methods for study of heart and lungs (Richard Gorlin and Warren, editors); (3) methods for the study of human leucocytes (Samuel P. Martin, editor); and (4) methods for study of the histology and cytology of the retina (E. N. Willmer, editor).

The first section deals with methods for preparing the structural proteins and enzymes of muscle, the quantitation determination of some of these substances, and some specific experimental techniques (e.g., measurement of ATP-ase activity, the glycerol-extracted muscle preparation). An isometric tension recorder is described by Myron O. Schilling.

The second section reverts in part to a topic covered in the first volume published ten years before this one. The advances in hemodynamic research make the "return performance" welcome. Some of the topics covered are the dye dilution method for estimating cardiac output; the Korner-Shillingford method for estimating the volume of valvular regurgitation; methods for intravascular pressure recording; left heart catheterization; the calculation of vascular resistance, cardiac work, and orifice areas; and the measurement of coronary blood flow. A discussion of kinetocardiography by Eddleman and Reeves of Birmingham is an excellent summary of this interesting technique for study of low-frequency precordial pulsations, but seems a bit out of place.

The leucocyte techniques discussed include sedimentation methods for separation of the white cells, methods for metabolic and biochemical study of surviving leucocytes, and tissue culture of leucocytes.

In the section on the retina the authors discuss choice of fixatives, embedding, and staining methods. The section on histochemical techniques is particularly full and will probably prove of great value.

VICTOR A. MCKUSICK

THE BIOLOGIC BASIS OF CANCER MANAGEMENT.

By Freddy Homburger; forewords by Lauren V. Ackerman, Clarence Cook Little, and Alton Ochsner. Hoeber-Harper, New York. $10.00. xviii + 354 pp. + 3 pl.; text ill. 1957.

This book is designed to provide the reader with an introduction to cancer as a disease entity and biologic phenomenon. Its subject matter is divided into 4 general categories dealing in succession with the etiology of cancer, the biologic behavior of cancer, the diagnosis of cancer, and the treatment and prevention of cancer. An effort is made throughout the text to describe our current understanding of neoplastic diseases in broad terms fashioned from data collected by biologists, pathologists, biochemists, physiologists, and clinicians alike.

In this era of scientific superspecialization, it would seem prohibitively ambitious for one person to undertake a synthesis of the existing cancer literature, composed as it is of the contributions of many investigative disciplines. Even though the author embarked on his task with a broad experience as an internist and cancer investigator, he wisely has not attempted a detailed review of the entire cancer problem. Rather, he has described the significant findings of the basic scientists and correlated them where possible with the observed clinical characteristics of these diseases. Each chapter is set forth in a clear and readable fashion, and all data are discussed in a perspective that is rarely attained in more restricted considerations of neoplastic disease. Further, each section of the text is supplemented by a pertinent bibliography.

It would seem that this book would be of most use to a medical student desirous of considering cancer as more than an incidental phenomenon met with in various clinical areas. It would be of equal value to the research scientist who wished to avail himself of a refreshingly broad look over this segment of scientific endeavor. In short, Homburger's book, both in concept and content, should foster a deeper understanding of cancer as a biologic phenomenon.

ALBERT H. OWENS, JR.

SCIENCE LOOKS AT SMOKING. *A New Inquiry into the Effects of Smoking on your Health.*

By Eric Northrup; introduction by Harry S. N. Greene. Coward-McCann, Inc., New York. $3.00. 190 pp. 1957.

In the words of the author, "This book is written in the firm conviction that the reader deserves a clear presentation of the pros and cons of the tobacco and health controversy, on which to base his own answer to a question for which the medical profession still has not supplied the answer." Careful scrutiny of this statement reveals something of a paradox. The reader need only read this book and he will be prepared to answer a question for which no answer is yet available!

Launching into the discussion with the statement that "a realistic survey of the world today reveals that after oxygen, food, and water, most adult humans concern themselves with a fourth item of consumption: tobacco"; and building on the premise that ". . . the habit is apparently here to stay, for it offers some degree of pleasure, solace and relief from the pressures of daily living", the author rests his case with the lament that "it is a paradox of our times that tobacco, the most universal of acquired human appetites, should become a major source of man's anxiety." Since the text does not indicate the source of any of these statements, one must assume that they are based on the author's personal investigations.

A major feature of the presentation is the author's skepticism of statistics, a skepticism so profound that it precludes both an understanding and an appreciation of the body of solid accomplishment that the statistical and epidemiological disciplines have contributed to the field of public health. For example, the recurring references to the possibility that the increasing number of lung cancer deaths in the United States may be due to

the increase in size and the aging of the population will leave the unknowing reader completely in the dark regarding such things as age-specific, or age-standardized mortality rates. Hence, the serious student of public health, or anyone else interested in the facts of the matter, would be well advised to read the original articles on the subject of smoking and health, articles which, fortunately, are still extant in the medical literature.

B. AUBREY SCHNEIDER

PSYCHOLOGY AND ANIMAL BEHAVIOR

STUDIES ON THE COMPARATIVE ETHOLOGY OF DIGGER WASPS OF THE GENUS *BEMBIX*.

By Howard E. Evans. Comstock Publishing Associates; Cornell University Press, Ithaca. $4.75 (paper). x + 248 pp.; ill. 1957.

At the close of this very fine and lucid monograph, Evans, who is well known for his systematic studies of wasps, remarks: "What a species *is*, ultimately, is not what its external structural features happen to be, but how it lives and, most important of all, how it came to be. Now that most species of animals have been described, it is time to find out what they are." His method of discovering "what they are" consists of an analysis of his meticulously objective and painstaking field studies of 13 species of North American *Bembix*, for no less than 11 of which he has assembled detailed and impressive biographies.

The field studies, to which fully two-thirds of the text is devoted, encompass the distribution, ecology, and general activities of the wasps, the preparation, architecture, provisioning, and closure of the nest which is burrowed into the ground, placement of the egg, the hunting and the prey, development within the nest, and attacks by parasites. Following the detailed accounts of the individual species, the overall behavior of *Bembix* wasps is considered in terms of reaction chains of instincts, central excitatory mechanisms, innate releasing mechanisms, and natural selection. The activity chains disclosed fall into 3 distinct categories. Evans points out that *Bembix* wasps are quite exceptional in this respect, for so far as is known there has been no comparable structural evolution within the genus, to which more than 100 species have been assigned. Indeed, Evans holds it unlikely that *Bembix* can be divided into defensible subgenera or sound species groups on the basis of structure alone.

Specific differences in behavior and ecology are discussed in a very interesting comparative analysis which leads to the now familiar and evidently quite general conclusion that each species has either its own distinctive niche or is geographically separated from potential competitors. The book closes with a consideration of the possible evolution of behavior in these wasps, directed especially to the origin and variation of patterns, to the recognition of primitive and specialized activities, to the degree to which activities may be correlated with structural characters, and so on. Future field studies will certainly provide an exacting test of Evans' conclusions, for there is sufficient correlation between morphological and behavioral characters to permit his fairly confident prediction of the behavior patterns of certain species not yet studied.

This is an original and admirable work, written in a very self-critical and modest manner. Though the material of Evans' study is unfamiliar to most biologists, the account could not be clearer, and the problems under consideration are central ones in biology today. True, some of the questions asked will be viewed in other terms by biologists of different backgrounds. Certainly, for example, not all will agree with Evans that "what a species *is*, ultimately" constitutes a fruitful or even genuine question in science. Be that as it may, such an impressive and ample account of a most interesting group of hunting wasps is provided that this monograph may well serve as a model and standard for future field studies of this sort, and in it the experimentally minded field naturalist will find absorbing problems explicitly posed him. The syntheses of taxonomic, behavioral, and genetic knowledge that works such as this one foreshadow, and that research of this sort requires, provide an enlivening forward development in modern natural history.

KENNETH W. COOPER

THE IMAGE OF THE HEART *and the Principle of Synergy in the Human Mind.*

By Daniel E. Schneider. International Universities Press. $6.00. xi + 267 pp. 1956.

This is a most unusual book. The author develops new theories concerning the synergy of heart-mind, based on the sonic activity of the heart, and its psychic representation as the "heart image"—theories which he relates to such diverse issues as the paroxysmal auricular and ventricular tachycardias of emotional origin, longevity, and the liberation of creative talent.

He sees the heart perhaps more as a neural organ than as a muscular one. He prefers the term cardiomyoneurium. The heart has its own brain (node), its efferent system (His' bundle), its afferent and efferent relationship with the central nervous system ending in the silent areas: tractus solitarius, caudate nucleus, and the frontal lobes. Beginning with birth and continuing through the vicissitudes of life, which are lumped as separation or dismemberment crises up to year 6 (i.e., until myelinization is completed), the heart and labyrinthine system register a normal type of synergy, and in moments of such crises a dyssynergy, or anxiety. This primal anxiety becomes repressed

through the development with growth of a newer integrative mechanism involving the cochlea and speech. The original sonic energy of the heart becomes ultrasonic, continuing to use the primitive neural pathways. An uneasy equilibrium develops between the ultrasonic and sonic systems, and favors repression. This is the ultimate meaning of the "Beyond the Pleasure Principle"—a point Freud missed since he knew nothing of sonics.

The psychosomatic syndromes involving the heart are viewed as defenses against overwhelming anxiety; e.g., in paroxysmal auricular tachycardia, the heart rate jumps to the level of the fetal heart, in an effort to achieve that state of complete security and its image of the resting heart (to judge from the dream material of patients with this syndrome). Treatment is not through medication but through analytic interpretation of this phenomenon to the receptive patient.

Schneider distinguishes four characteristics in those who succumb to early coronary attacks: (1) a kind of controlled tension, relaxation spelling danger; (2) a perpetual physical hurry, appearing to be hurrying to, but actually away from, a deeply concealed dread; (3) pressure from ambition affecting the patient in a peculiar way, with the necessity to avoid accusation or to achieve self-purification; (4) evidence of a "healed split" in the identification process of childhood, with strong transvestite tendencies, well concealed or denied; and (5) a personality the antithesis of that of the creative artist, and exemplified in the eternal busy-ness of the professional worker, scientist, or business man.

Auditory hallucinations and other schizophrenic phenomena are viewed by Schneider as resulting from dissociation of the sonic-ultrasonic integrations. Echolalia (and likewise echopraxia) is a sonic phenomenon resulting from the breakdown in the "damping" activities coincident with cerebral disintegration (third frontal convolution and temporal lobe?). Taste is not a primary sensory phenomenon but a specific, unrecognized cholinergic synthesis of essentially erotic sensation with definite qualities of pain-pleasure affect to which are attached—semantically—repellent ("bitter") at one pole and attractive ("sweet") at the other pole of the synthesis.

This brief statement hints at the sweep of the author's theories. He rewrites a good deal of classical neurology (especially the Sherrington—Hughlings-Jackson theories of integration and the taste theories). He discards completely the Pavlovian postulate, and discovers the meaning of anxiety which escaped Freud—all through emphasis on the sonic energy of the heart and the heart-mind synergy.

He may be right in asserting that the heart is the only internal organ which registers with an internal "note." But the gastrointestinal system surely registers in its own way. Could not a convincing theory be spun with respect to it?

This is a most unusual book. Is it a valuable one? There is supporting material from so many fields—neurology, psychiatry, psychoanalysis, electrophysiology, etc.—that only the combined testimony of experts from all of them would give an answer. Provocative, certainly. Helpful in treatment? In Schneider's hands, apparently yes. For the rest of us ——?

WENDELL MUNCIE

HUMAN BIOLOGY

MAN AS AN ANIMAL.

By W. C. Osman Hill. Hutchinson University Library, London; [Rinehart and Company, New York.] $1.50. 176 pp.; ill. 1957.

A remarkable amount of useful information is packed between the covers of this small book by one of the leading living students of primates. Such topics as the anatomy, development, physiology, pathology, psychology, and genetics of man and other primates, primate paleontology, and human races are covered, of necessity succinctly, yet ably and with authority. This is a good book for the intelligent laymen who wishes to gain some insight into his own place in nature.

W. L. STRAUS, JR.

PREHISTORIC MAN.

By A. Leroi-Gourhan. Philosophical Library, New York. $4.75. xvi + 121 pp.; ill. 1957.

This little book, by the director of the Museum of Natural History, Paris, is a delightful and excellent introduction to the study of human prehistory. The sections which deal with the culture of prehistoric man—with his works and his mode of life—and which constitute the major part of the volume, are written with authority, yet without complexity; thus they should appeal to both the beginning student and the intelligent layman. The pages that explain the techniques involved in the making of stone tools are exceptionally outstanding. The illustrations are excellent. Unfortunately, there is no list of references to the literature.

W. L. STRAUS, JR.

MAN AND WIFE. *A Source Book of Family Attitudes, Sexual Behavior, and Marriage Counseling.*

Edited by Emily Hartshorne Mudd and Aron Krich. W. W. Norton & Co., New York. $4.95. xxvi + 291 pp. 1957.

Although originally intended as a source book for senior medical students at the University of Pennsylvania, this book should be of interest to other professionals whose work brings them in contact with marriage problems. Seventeen contributors representing

diverse fields—psychiatry, sociology, law, medicine, social work, child therapy, and religion—attempt to provide an informed and constructive approach for helping troubled marriages. The editors' thesis is simple: that people may need help urgently from objective, informed, sympathetic individuals without needing psychiatric therapy, and that marriage counselors and professional persons in related fields are often in a position to spot and help with such problems.

The chapters are divided into four parts: The Making and Breaking of Marriage; the Moral Climate of Marriage; Mating and Mismating; and the Meaning and Process of Counseling. The philosophy, methods, and limitations of marriage counseling are carefully observed, with the necessary background information, albeit compressed, covered in individual chapters. The nature of the book precludes a comprehensive treatment of specific problems. However, those chapters dealing with sexual adjustment, as well as the practical aspects of marriage counseling, are especially good.

There is also a worthwhile appendix which includes additional suggested readings and a list of national organizations (with name, address, and purpose of each) operating in this general field. The index is adequate.

THELMA S. NASON

A DEVELOPMENTAL QUESTIONNAIRE FOR INFANTS FORTY WEEKS OF AGE: AN EVALUATION. *Monogr. Soc. Res. Child Develop., Vol. XX, Serial No. 61, No. 2, 1955.*

By Hilda Knobloch and Benjamin Pasamanick. Child Development Publications, Lafayette. $2.50 (paper). 112 pp.; ill. 1956.

The investigation reported here is one part of a long-term study of prematurely born infants which is being conducted at the Johns Hopkins University School of Hygiene and Public Health. A Gesell Developmental Examination was given to 992 infants and a 40-week questionnaire was completed by the public health nurse for 901 of these babies. White infants constituted 43.4% of the total sample. The diagnostic category assigned to each infant by the physician's examinations was used as the basis for making comparisons with the results of the nurse's questionnaire. Ratings were assigned as *Normal*, *Intermediate* (showing some departure from normal behavior, but requiring no particular follow-up), or *Abnormal* (indicating apparent signs of neurologic or intellectual damage such as to warrant careful observation).

There was agreement between the two methods (doctor; nurse) in 84.6% of the total cases. Of those called normal by the clinical estimate of neurological status plus intellectual potential, none was graded abnormal by the developmental quotients. However, more infants were given intermediate or abnormal ratings by the physician because of some neurological involvement without concomitant intellectual impairment. The manner in which the nurses were prepared to use the questionnaire and the validity and adequacy of the questionnaire are carefully scrutinized.

The summary reveals that "the screening device falls short of the goal of referring for evaluation all of those cases which the physician's examination call abnormal and none of those diagnosed as being normal. Approximately one quarter of the abnormal cases were missed by the nurse's questionnaire."

The study includes a list of recommendations for improving the screening process, four appendices, and four tables. This study can be recommended for its carefully planned basic design and the objective evaluation of its findings.

J. H. CONN

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

SCIENCE IN PROGRESS: *Tenth Series. Sigma Xi—Resa National Lectureships 1955 and 1956.*

By Vannevar Bush and 13 contributors; edited by Hugh Taylor. Yale University Press, New Haven. $6.50. xviii + 253 pp.; ill. 1957.

As the Preface states, this volume of the series *Science in Progress* "... reflects in part the increasing concern of scientists with the impact of science in the world outside the laboratory and library." The opening article, a provocative discussion of Science and Progress by Vannevar Bush, has slight overtones of chagrin at the way in which the world has conducted itself. The second article, written by Paul B. Sears, deals with Science and Natural Resources and definitely should be read by every thinking person. Social Attitude toward Invention, an essay by Eugene Ayres, is similarly a discussion which is of general concern. The remaining papers in this volume are of more limited interest, in the sense that they are directed toward the intelligent layman who has a particular interest in science, and toward the scientist who himself works in some different field of research than the author. The various branches of science are well represented: Piltdown Man (Kenneth P. Oakley and J. S. Weiner); The Life History of the Cell (Daniel Mazia); The Role of Environment in Plant Growth (F. W. Went); Control of Growth and Reproduction by Light and Darkness (Sterling B. Hendricks); Molecular Mechanisms in Inflammation and Stress (Henry Eyring and Thomas F. Dougherty); Surgery's New Frontier—the Heart (Robert P. Glover and Thomas J. E. O'Neill); Use and Abuse of Earth Waves (L. Don Leet); and Chemistry as a Supplement to Agriculture in Meeting World Food Needs (Robert R. Williams).

V. G. DETHIER

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

Theoretical papers are published occasionally, especially when such papers (1) include a critical synthesis of the literature bearing on the theory and (2) are likely to promote further research in a given field.

The article should be written in concise language, yet in sufficiently non-technical form as to be intelligible not only to specialists in other fields but to the general biologist as well. To this end the article should have a general introduction and a summary which enumerates one by one all of the principal facts and conclusions given in the paper. Interpretative diagrams and schemes are very desirable.

Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature.

The subjects and authors of articles are selected by the Editors and members of the Advisory Board. Unsolicited articles which conform with the objectives of the Quarterly will be considered for publication.

A feature of the REVIEW is the section dealing with *New Biological Books*. In this department the book literature of different countries in the field of Biology is given comprehensive and critical attention.

The QUARTERLY REVIEW OF BIOLOGY is issued in March, June, September and December.

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